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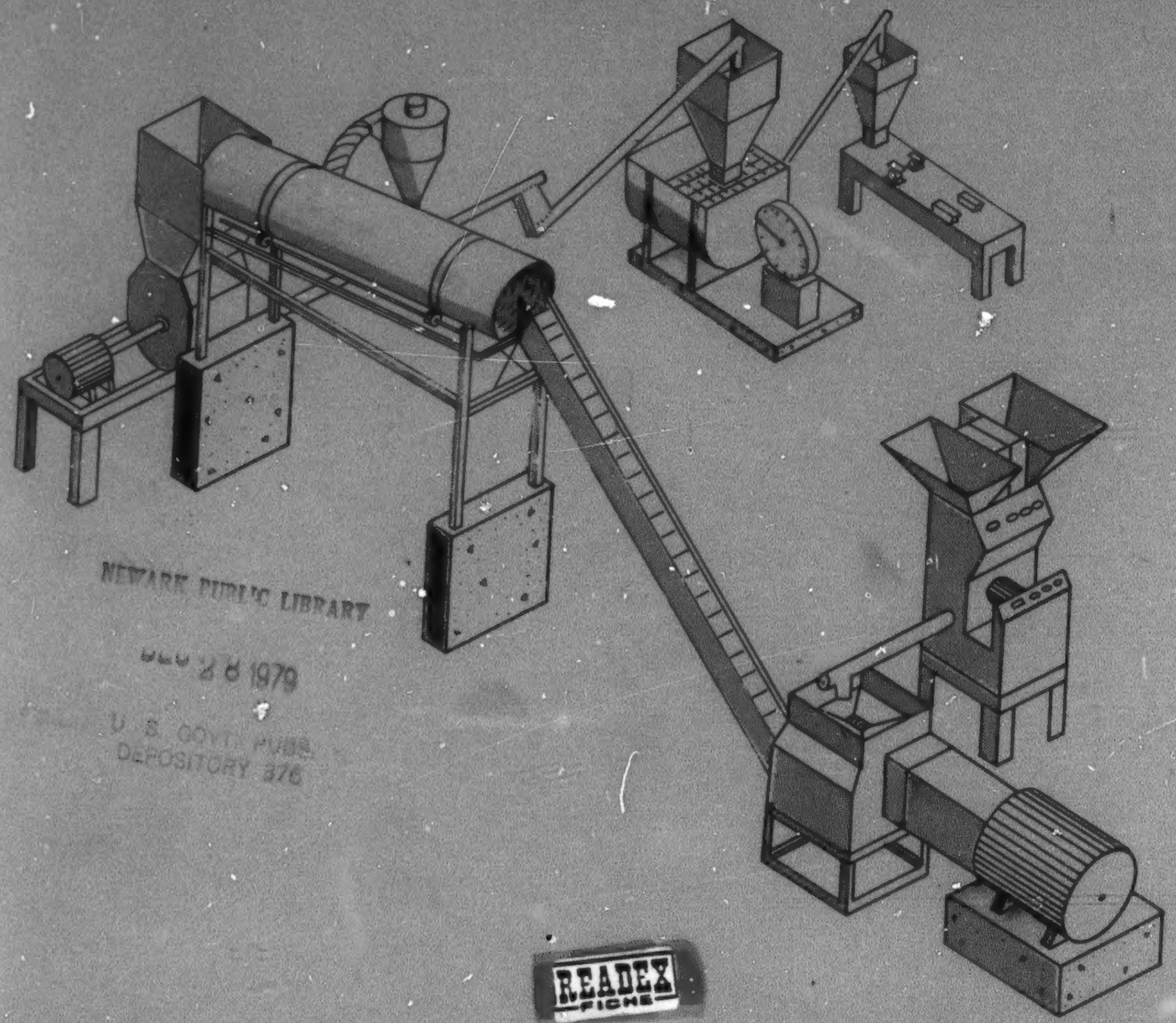
low-cost extrusion cookers

Second International Workshop
Proceedings
January 15-18,1979
Hotel Kilimanjaro
Dar es Salaam
Tanzania



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No. 3 Evaluation of Low-cost Extrusion Cooker in Sri Lanka (Special
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No. 4 Evaluation of Low-cost Extrusion Cookers for Use in LDC's
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No. 5 Mechanical Evaluation of Brady Crop Cooker #206 (Special Report),
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No. 6 Evaluation of Low-cost Extrusion Cookers for Use in LDC's
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LOW-COST EXTRUSION COOKERS

SECOND INTERNATIONAL WORKSHOP PROCEEDINGS

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Office of International Cooperation and Development
Nutrition and Agribusiness Group

Hotel Kilimanjaro
Dar es Salaam, Tanzania

January 15-18, 1979

Acknowledgment

The editors gratefully acknowledge the support of the Agency for International Development and the assistance of the U. S. Department of Agriculture in carrying out the second international workshop on low-cost extrusion cookers (LEC) and in publishing these proceedings. They also extend their appreciation to the workshop participants, whose contributions add to the growing body of useful information on LEC technology; to Mrs. Peggy Stumpf for her help in planning the workshop and preparing the proceedings; and to Mrs. Ruth Rodgers and Mrs. Nina Blocker for their typing assistance.

The views expressed herein are those of the speakers and do not necessarily reflect official positions or policies of the agencies represented.

Preface

When we gathered in Fort Collins nearly three years ago to discuss low-cost extrusion cooker (LEC) technology, the picture differed significantly from today's. Whereas the majority of LEC projects were just on the drawing board at the time of that first international workshop and tentative expressions of interest were the order of the day, reports at Dar es Salaam were of actual testing and production experiences. This time the mood was one of enthusiastic optimism based on results.

It was heartening to hear how much LEC technology as a means to produce nutritious foods at low cost has spread in a relatively short time. For example, the Tanzania plant is producing a baby food called "Lisha," composed of locally-grown maize and soy, milk, and imported vitamin and mineral additives, for distribution to maternal-child health centers. Other applications include the manufacture of "Thriposha" for food donation programs in Sri Lanka, where construction of a new dual Brady cooker processing complex is slated for completion this fall. In Costa Rica the recently installed CARE plant, jointly financed by CARE and an AID operational program grant, is scheduled to begin production of fortified CSM and full-fat soy flour in May. In Bolivia, where initial production of "Maisoy" was for use in government feeding programs, the Nutrinal Company is now marketing its expanding line of Brady-processed products commercially. The Guyana Pharmaceutical Corporation in Georgetown is currently engaged in test marketing and plans to begin production of its LEC baby food "Cerex" in 1979. In Chihuahua, Mexico, Brady-processed full-fat soy flour is being used by Productos Alimenticios Delicias as a fortifying ingredient in a variety of food products sold in the marketplace. Other countries, such as Thailand, Honduras, and the Philippines, are involved in product formulation and testing or other activities preliminary to establishing production facilities. And additional formulations are being tested on Brady cookers provided for that purpose in Pakistan and Guatemala.

As Dr. Martin Forman of AID's Office of Nutrition points out in his letter on the following page, these developments in LEC technology transfer are the result of cooperation among "like-minded people from different organizations in a variety of settings." It is true that since AID first provided funds for this program through USDA to Colorado State University in 1974, many people in many countries have made valuable contributions to its success. An outstanding example of this collaborative attitude is the National Milling Corporation's willingness, on behalf of the Tanzanian Ministry of Agriculture, to co-host the workshop in Dar es Salaam. Their gracious hospitality and that of their countrymen will not be forgotten. And in the same vein of cooperation, we would be remiss not to cite the USAID Mission in Dar es Salaam for providing indispensable support services.

It is a pleasure for us to transmit to you the formal proceedings of the workshop.

G. Richard Jansen
Project Co-Director
Department of Food Science
and Nutrition
Colorado State University

R. E. Tribelhorn
Project Co-Director
Department of Agricultural
and Chemical Engineering
Colorado State University

Letter from Dr. Martin J. Forman, Director, AID Office of Nutrition, to Dr. G. Richard Jansen, Project Co-Director, Colorado State University

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

January 10, 1979

Dr. G. Richard Jansen, Project Co-Director
Department of Food Science and Nutrition
Colorado State University
Fort Collins, Colorado 80523

Dear D[illegible]

The 1970's have certainly been turbulent years for international nutrition. When the decade began, there was still a strong clamor to attack the "protein crisis"; a short time later understanding of nutrition requirements changed, and the "crisis" diminished sharply. In 1970, the "green revolution" was still being hailed as a dramatic break-through which held high promise for solving the world's food supply problem; shortly thereafter, the alternating weather years, first bad, then good, brought back the reality of how dependent world agricultural production still is on the weather. Oil prices went up in the mid 70's and the price of agricultural inputs--and food--went haywire.

The 1974 World Food Conference produced a consensus by governments and international aid agencies on the need for drastic action in agricultural development, food security, food aid and nutrition. Four years later the follow-up record is mixed. Some of the sense of urgency has disappeared, and the track record in responding to WFC nutrition recommendations is poor.

One thing that has remained constant throughout the period, however, is the steady and persistent progress being made by a small army of private voluntary organizations, the rank and file workers in government nutrition programs, and a dedicated group of pragmatic professionals who have somehow managed to employ new technologies and scientific methods without losing touch with the realities at the grass roots level.

A number of modest but important developments have occurred. None is earth-shaking by itself, but each contributes to the objective of reducing malnutrition in developing countries. The achievements are little heralded, but they make their impact on the people who are served, and they slowly but surely spread to affect additional people and programs.

I believe the developments in low-cost extrusion cooking over the past four or five years are a good example of the way in which sound research and development should be carried out to test and introduce a new technique. It required imagination, the courage to proceed with a new idea, patient and diligent testing, restraint to avoid oversell, technical and managerial excellence and the cooperation of like-minded people from different organizations in a variety of settings.

The number of projects has been small, but the high quality of these efforts has produced answers which will make possible intelligent policy and programming decisions regarding low-cost extrusion cooking in the years ahead.

I regret that I cannot attend the workshop in Tanzania, for I would have enjoyed hearing progress reports first-hand, and I would have liked to participate in the discussions and decisions regarding next steps. I will, however, look forward to reading the proceedings and talking to you when you return from the workshop.

In the meantime, I wish you a stimulating and enjoyable meeting. Please convey my regards to our many friends and colleagues at the meeting and express my thanks to the Government of Tanzania authorities who have graciously offered to co-host the meeting.

Sincerely,

Martin J. Forman, Director
Office of Nutrition
Development Support Bureau

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1/ Mr. Kepakepa is employed by the Tanzania Food & Nutrition Center and is on assignment to NMC.

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Welcome

Johnson W. Kihampa
Executive Chairman
The National Milling Corporation
Dar es Salaam, Tanzania

On behalf of all workers of the National Milling Corporation, I have much pleasure in welcoming you to this workshop, the first one of its kind in this country.

This workshop has been organized at a time when you will be able to see the opening of the baby food plant, which was built through the initiative of the United States Agency for International Development as represented by Dr. Richard Podol, who initiated and supervised the complete installation of the plant. In addition to the technical know-how which USAID provided through Colorado State University, the United States also provided all the machinery, valued at US $50,000.

It may be appropriate here to give a short background history of the baby food plant. As I mentioned earlier, the initiator of the plant was USAID. The National Milling Corporation, on behalf of the Government of the United Republic of Tanzania, agreed to house the project at their premises at Pugu Road Branch. For this purpose one of the old NMC buildings had to be renovated to suitably accommodate the machinery. This work cost the NMC about T.Shs. 200,000. 1/

Typical scene in Dar es Salaam's busy harbor.

The National Milling Corporation also provided all the technicians required to install and ultimately run the plant. Tribute must be paid to Mr. B. Nyakunga, chief engineer of the corporation, who worked hand-in-hand with Doctor Podol in the overall supervision of the installation of the machines.

Ladies and gentlemen, certainly my welcoming speech would be incomplete if I didn't mention here the useful work performed by the coordinating committee, composed of representatives from NMC, USAID, Tanzania Food and Nutrition Center, MCH, TISCO, etc. It is through their good work and timely advice that the successful installation of the baby food plant has been achieved. The food plant was completed during the first quarter of 1978, and it was commissioned by CSU in May of the same year.

The factory has a capacity of 4 tons of baby food per day operating for one 8-hour shift. It may interest you to know that most of the raw materials used are obtained locally; only the vitamin and mineral premixes and milk are being imported from the U.S.A. The food is being packed in 2-kg. polythene transparent plain or printed bags. For ease of transportation, these bags are also put into 20-kg. cartons before they are dispatched to the regions.

Our baby food is known by the name "LISHA," which means "feed," and until now we have been able to distribute it to a number of health centers where MCH serves it to infants under five years old. However, we have not yet been able to distribute LISHA to all regions; as a trial exercise, we have limited distribution to such regions as Dar es Salaam, Coast and Tanga. We are intending to extend the service to Morogoro and Dodoma Regions in the not-too-distant future.

Regarding the workshop for which we have gathered here, I wish to express, on behalf of all my colleagues, my sincere thanks to USAID, which represents the government of the U.S.A., for organizing it. It is my fervent hope that all participants in this workshop will seriously absorb all the good knowledge that will be delivered to them by the experts from the various countries. For Tanzania this workshop is

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1/ Approximately $27,000 at the current exchange rate of T.Shs. 7.40 = $1.00.

taking place at a most appr[illegible]ate time, for we need experts in the field which is being discussed in this workshop. Fortunately, too, the workshop happens to take place during "Children's Year," as the year 1979 has been universally declared. So we can hopefully say that this is a workshop that is being conducted at the right time and certainly at the right place.

Mr. Chairman, ladies and gentlemen, I need hardly emphasize here the importance of producing good nutritious food for our children all over the world. especially in the developing world. We in the developing world still experience a painfully high rate of infant mortality, and one of the major causes for this calamity is the lack of proper and balanced food for infants. The organization of this workshop is definitely an event that is most welcome by all child-loving parents of our country.

Last but not least, may I kindly take this opportunity to welcome you to Tanzania. I hope you will enjoy your stay in our country and will feel quite at home.

I wish you a very successful workshop.

Opening Remarks

The Honorable James Spain
U.S. Ambassador to the United Republic of Tanzania
Dar es Salaam, Tanzania

Thank you, Dr. Jansen. It's a pleasure for me to address the opening session of this workshop.

Most of you in this room are development people. My profession is that of a diplomat. Now diplomats, at all cost, avoid friction — when nations press too closely against each other, try to compress too tightly their affairs; or when they otherwise crowd each other, there is always trouble. You, on the other hand, seem to have taken the principle of friction and found a way to make good nutritious food out of it. If you have an extra hour during the upcoming days, I think the world would be very grateful if you could figure out a way to transfer that technology to diplomacy.

The thesis "Feed the Hungry" is a central one in all the great religions and, I think, all the great secular societies. It is probably one of the few universal principles in the world. My particular experience here during the past three years in Tanzania has been that while at this point in history many issues of the world are not going very well, this one at least as I have seen it here is going quite well.

Three years ago the principal business discussed by our government and the Government of Tanzania was in the food area. The main thing we talked about to the National Milling Corporation and to the other state agencies was Public Law 480 — food imports — to try to help take care of the gap that resulted from the drought of 1974-1975.

Yet this week a group is gathered here to talk not about food imports, locally produced food or increasing food production, but rather how to apply a new and very important technology to locally-produced food. Things have come a long way.

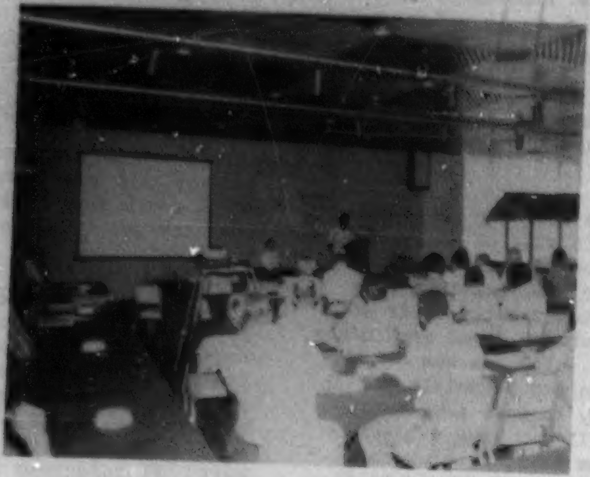
In Tanzania and in a number of other countries this progress in making food available, it seems to me, has brought a couple of other concepts with it that are terribly important. One really is equity, egalitarianism, justice — whatever you want to call it. It is the idea that no one should live in plenty and luxury while someone else is hungry. That wasn't merely a question of producing food and applying new technology to it, but trying to do so in such a way as to see that the benefits got to all of the people.

Another concept, which again I have seen played out very successfully in the past three years here, is that of self-sufficiency — the idea that not only should a government or leadership be able to produce the food its people need, but that it should be able to do so in a consistent, reliable and dependable way. This ultimately means doing it yourself. The progress in this area we have seen here is evident even in our manner of talking. Mr. Madallali and I used to talk about when a shipment of maize was coming in and what the storage situation was. Today we are here talking not about what you do to that maize or how you produce more maize to fill his warehouses, but what you can do to serve a particular purpose, that of making weaning food, with the grain produced here already in his warehouses.

Modern architecture dots the Dar es Salaam skyline.

What you are doing here this week, therefore, is very important indeed; and it is as important to me and my kind as it is to you. I am very grateful that you asked me to come, and I offer my most sincere good wishes for a very successful conference. May any friction you generate in your discussions be exclusively of the kind that produces good, nutritious, intellectual food and — as I'm sure the sponsors would want me to say — at low cost.

Thank you.



Participants are welcomed to the workshop.

Opening Remarks

Dr. Howard Steverson, Director
U.S. Agency for International Development
Dar es Salaam, Tanzania

Thank you, Dr. Jansen. Good morning, ladies and gentlemen. On behalf of the USAID Mission to Tanzania, let me extend to you a hearty welcome.

I'm like the new guy on the block in terms of the LEC activity. I've been here only eight months, so I really can't take a lot of credit for having developed the low-cost extrusion plant. Nevertheless, I have had the great honor to watch its growth. And we are especially pleased to be a part of the sponsorship of this conference.

I am going to let you move right along. I look forward to seeing all of you during the week and getting to know you on a personal basis.

Thank you very much.

Inaugural Address

Dr. S.A. Madallali
Principal Secretary
Ministry of Agriculture, Tanzania

Ladies and Gentlemen,

It gives me great pleasure to be here today amidst technicians and international organizations interested in one of our basic responsibilities--that of combating malnutrition, which is so vast in the developing world. On behalf of the Ministry of Agriculture and my Government, I have the honor to welcome you to Tanzania, and to Dar es Salaam in particular. I am sure you will enjoy your short stay and deliberate effectively on how this new technology will help towards providing the much-needed low-cost nutritious supplementary foods.

The necessity for balanced and nutritious foods for humanity, and especially so in developing and undernourished countries, cannot be over-emphasized. Toward this objective, the Agency for International Development (AID), through a contract with the U.S. Department of Agriculture, has actively supported and directed efforts to identify methods of producing nutritious foods at low cost in developing countries.

One such method is that of extrusion cooking of indigenous cereals and legumes. The extruder used here is the Brady crop cooker, a simple inexpensive machine designed in the U.S. which has been tested at Colorado State University and found to be an appropriate means of making nutritious foods and food ingredients. Additional tests conducted elsewhere, for example, the East African Industrial Research Organization in 1975-1976, confirmed the positive results. As part of its testing program, EAIRO produced 1-1/2 tons of maize/soya blended weaning food for acceptability trials by the Tanzania Food and Nutrition Center, a Tanzanian parastatal entity charged with food and nutrition issues.

Geared towards the government policy of achieving self-sufficiency, and based on the encouraging results of the tests, the National Milling Corporation, a government parastatal organization responsible for grain (cereals & legumes) procurement, storing and processing, requested assistance through USAID in the form of a Brady crop cooker and ancillary equipment for the production of a weaning food. As it was planned, the food is composed of locally-grown maize and soya beans, milk and imported premixes, viz., vitamin and mineral additives, so as to produce a balanced, nutritious finished product.

The machinery was provided as requested and was installed by the National Milling Corporation. Test runs were conducted with expert advice from Colorado State University representatives. The initial production has been turned over to and distributed through the Ministry of Health's Maternal-Child Health Centers. U.S. Government funds were provided by the Office of Nutrition, Development Support Bureau, in Washington, D.C. The local USAID office has all along worked closely with Tanzanians in the preparation and implementation of this project.

Ladies and gentlemen, just in passing it is worthwhile mentioning that the scope of low-cost extrusion cooker activities is worldwide, and that it has a lot to offer to developing countries. The presence here of representatives of some seventeen (17) nations attests to its importance. Testing units have been or are currently located in Guatemala, India, Indonesia, Thailand, Kenya and Pakistan, while demonstration/production facilities are in operation in Costa Rica, Sri Lanka and, of course, here in Tanzania. It is believed that more will be heard in the course of deliberations and discussions during the workshop about various institutional or personal experiences.

For us in Tanzania we are witnessing again the endless efforts within government policy to develop our country towards self-sufficiency in various sectors. It is within this policy that we hail the inception of the Brady cooker for the preparation of low-cost weaning food -- a project which will to a large extent be dependent on locally-cultivated crops, thereby acting as a stimulus towards utilization of our agricultural products, and in effect encouraging increased farm production as well as serving the purpose of substituting local foods for imported weaning foods or their equivalents.

We also wish to note in appreciation the contribution made from the donor country, i.e., the U.S., in assisting the endeavors of developing countries in areas such as this. The goal of improving human life as part of the international concern for development is one we in Tanzania share. We will work tirelessly towards such aims and objectives so long as they contribute to the well-being of a people. The outcome of this workshop is being awaited eagerly by my ministry as we wish to conserve our meagre resources and to spend them on very pertinent projec Technology which is a shortcut to our need should be given high priority.

Ladies and gentlemen, I do not want to delay your program. You have much to learn from each other in this workshop. Please d discuss freely and a friendly manner, as yo are in a friendly country. On behalf of th Ministry of Agriculture, I hereby declare the workshop open and wish you great resourcefulness in your discussions.

Thank you.

An Overview of the AID Nutrition Program

Dr. Albert Henn
USAID Health, Nutrition and Population Officer
Dar es Salaam, Tanzania

I have been asked by the Office of Nutrition in Washington to provide you on their behalf a feeling for the general AID programming context in which the LEC projects are being undertaken. The aim of AID, in general, is to contribute to improving the quality of life of the poorest people in the developing countries, which cover about two-thirds of the earth's land area and contain about 74% of the world's population. An estimated 25% of the world's 4 billion people currently are considered malnourished or are consuming less than 80% of the daily food requirement. There is severe malnutrition in every low-income country, where the most vulnerable population groups--children in the first years of life and pregnant and lactating women--suffer from the consequences of malnutrition and usually benefit last and least from increases in family income.

Malnutrition is increasingly recognized worldwide as one of the basic deterrents to overall development. I am not making these remarks to convert any of you, but to set the scene for the Congressional mandate that AID operates under. It is estimated that as many as a billion people are economically less productive due to nutrition-related problems than they might be. The United States Congress, in reacting to this situation, has directed AID to give its highest priority to food and nutrition assistance programs. Most of AID's responsibility under this mandate is directed toward increasing agricultural output, yet a portion of AID funds is devoted explicitly to nutrition programming. The annual AID nutrition budget has grown from $6.5 million in 1973 to a current level of over $50 million. This represents about 10 percent of the overall food and nutrition budget of AID.

There is an Office of Nutrition at AID headquarters in Washington which is responsible for the development of agency nutrition assistance strategies and for management of the AID nutrition programs in a way which is responsive to the need of the underdeveloped countries. The AID nutrition strategy is to increase the abilities of such countries to (1) analyze the nature, causes and magnitude of their basic nutrition problems; (2) determine the most productive, cost-effective and affordable ways to strike at the root causes of malnutrition; and (3) plan, implement, monitor and evaluate their own nutrition programs. This relates to the whole concept of self-sufficiency, which is held to be so important by the Tanzanian Government and which makes the low-cost extrusion cooker project so relevant to local needs in this instance. This strategy emphasizes that combating malnutrition requires a coordinated effort involving agriculture, health, education, regional development--a cross-sectoral approach. It focuses on alleviating malnutrition among the groups at highest risk: preschool children and pregnant and lactating women.

Most nutrition funds come from what we call Section 103 funds, Food and Nutrition. Yet some nutrition-related activities may not be identified as such on AID's financial and accounting records. We have a lot of programs which impact directly on the nutritional status of individuals which come out of our agricultural programs, out of health programs, out of education, use of mass media, etc. These include such things as development and transfer of technology adapted to the problems of small producers; improving access by small producers to inputs, credit and markets; facilitating the development and improved utilization of land and water resources; and assisting the development of rural infrastructure and of the institutions to serve the rural poor. As examples, AID has actively been involved in the production and multiplication of improved seeds in Rwanda, Tanzania, Cameroon, Nepal and Morocco; credit programs geared to small farmers in Tanzania, Bangladesh, and several other countries; land registration, redistribution or resettlement; small-scale irrigation; the production of labor-intensive, high-value, nutritious commodities such as grain legumes; improving marketing systems for small farmers; supporting the development of cooperatives and other small farmer organizations; and assisting rural access road development.

In many of these cases, the primary production and consumption decisions are being made by women. Yet traditionally the development community has been insufficiently sensitive to their needs and to the constraints affecting their productivity and well-being. Given the critical role of women in the causality of malnutrition and as primary targets of nutrition improvement, there is a clear need for greater cognizance of women in the broader context of agricultural and rural development.

The agency has been less active operationally in programs designed primarily to generate employment for the landless, although it has provided assistance in the development of rural work programs in Bangladesh and Afghanistan. On the other hand, AID is financing research studies on participatory rural development and the rural poor and has been giving serious attention to the issue of integrated rural development. Finally, the agency has been doing work in the area of post-harvest food losses. The nutritional implications of reduced losses will depend importantly upon their effects on consumption by the poor directly or through their effects on food prices.

In the health sector, AID has a number of broad maternal self-health or cross-sectional programs which impact upon nutrition. Some of the best-known of these are the program in Thailand for the development and evaluation of a low-cost system for delivery of integrated health, population and nutrition services; and the development of a quasi-public institute in South Korea organized through the Economic Planning Board to design and operate a rural health delivery system according to local needs. There is a long list of additional health projects--which I won't recite now--which contain important segments dealing directly with nutrition problems.

In addition to agriculture, rural development and health projects discussed above which have an indirect, although important, effect on nutritional well-being, the agency has been designing and implementing programs which bear directly and exclusively on malnutrition problems. These are those primarily which are overseen by the Office of Nutrition. AID inputs have been in the form of technical assistance, loans, and PL 480 food commodities. Technical assistance to date has concentrated on nutrition planning and analysis, the determination of effective nutrition interventions and on what might be called research backstopping or extending the state of the art in human nutrition.

In the area of planning and analysis, AID has been assisting a dozen countries, thus far, to develop a certain capacity for national and local nutrition planning. One useful instrument in this process has been a simplified means of assessing nutritional status. Such AID-assisted surveys have now been carried out in five countries, and six additional surveys are planned in the current fiscal year. These are surveys which have been undertaken in the past by Dr. Jelliffe at the University of California at Los Angeles and the Nutrition Unit of the Center for Disease Control in Atlanta. The nutrition planning support has, in large part, been implemented through a contract with the New Transcentury Foundation, which has placed six or seven intermediate nutrition planners in the appropriate ministries in various countries. In Cameroon, my previous post, the individual was placed in the Ministry of Economic Affairs and Planning.

Closely related is the assistance in the design, implementation and evaluation of direct nutrition intervention programs. AID has been actively involved through regional bureaus and missions, as well as through the Development Service Bureau, Office of Nutrition, in carrying out systematic studies to determine the relative cost and effectiveness of child feeding programs, nutrition education, food fortification, and programs of plant breeding for nutrient content and quality. Of these direct interventions, the agency has singled out the following for special attention during the next few years: (1) Village-level identification and follow-up of children at risk using weight surveillance, nutrition education, and food supplementation. Such programs are being developed in the Philippines, Colombia, Indonesia, and several Central American countries. (2) Interventions designed especially to reduce iron deficiency, anemia and vitamin A deficiency. AID has taken the initiative in organizing international advisory consortia on both iron and vitamin A. Operational activity is underway in Haiti, Guatemala, Indonesia, Sri Lanka, and El Salvador to develop programs aimed specifically at the vitamin A problem. (3) The development of intermediate appropriate technologies primarily for the production of weaning foods and for food fortification. One example is the low-cost extrusion cooker developed in the United States to process soybeans for feed on the farm, but capable of producing precooked, easily digestible foods for young children. Such cookers are now in place in Central America, Tanzania, Sri Lanka, Thailand, and the Philippines, among others. (4) Interventions designed to change deleterious weaning practices, primarily delayed provision of solid food and early cessation of breast feeding. Affecting these practices could have significant effect on mortality and morbidity, the primary measures of long-term nutritional change. The Office of Nutrition has been testing some potentially attractive means of affecting these practices through the use of mass media and extension techniques. Each of these activities assumes considerable inputs from U.S.-based and indigenous private voluntary agencies. One of the things that the Office of Nutrition is best known for within the agency is the degree to which it has supported the nutritional activities of private voluntary organizations--and I think that probably the majority of the nutrition programs being undertaken in the developing world are being undertaken through such organizations.

In terms of research backstopping, the agency has attempted to increase understanding of nutrition requirements under differing sets of conditions, the relative importance of caloric and protein deficiencies in populations, and the relationships of these deficiencies to disease resistance. Direct technical assistance is being provided under development grants and development loans to more than 15 countries. Loans to implement specific nutrition effots have been approved for Chile, Colombia, Costa Rica, the Dominican Republic, Honduras, and Panama. In the case of the Dominican Republic and Panama, the loans cover both health and nutrition activities, but a specific component of the loan is earmarked for nutrition. Additional loans are under consideration for Nicaragua and Bolivia. These approved and proposed loans approximate $33 million. Development grant activities have been funded under AID technical assistance programs to Bolivia, Nicaragua, Brazil, Peru, Pakistan, the Philippines, Thailand, Zaire, Morocco, Tunisia and Haiti. These efforts amount to approximately $15 million. Additional nutrition activities are under consideration for inclusion in the programs of about six additional countries. Most of these activities, either development loans or development grants, fund programs in national nutrition planning, nutrition education, data collection or training and food supplementation programs.

The agency to date has been uneven in its initiation and development of direct technical assistance and loan activities in nutrition. While the Latin American Bureau and Latin American missions are increasingly well-staffed and organized to make these inputs, there have not been commensurate inputs in other regions despite considerable effort by the limited staff available. It is certainly true in Africa that nutrition programming is really just getting underway on a large scale.

Aside from the PL 480 support, seen by the agency as an interim measure to help serve as a buffer between the present time and when countries become self-reliant and are able to meet their food needs locally, I think this gives you an overview of the general kinds of activities in nutrition that AID is involved in and also gives you an idea of where the low-cost extrusion cooker project fits in this scheme. We expect that this workshop will be a valuable experience for you all, and we know that it will be valuable to AID in terms of the issues that are dealt with, such as marketing and management problems. We are looking forward to working with answers that this workshop adds to the state of LEC technology, and from the standpoint of USAID/Tanzania, I would also like to welcome you all to Dar es Salaam.

Transferring LEC Technology to Developing Countries: From Concept to Application and Beyond

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In setting the stage for our workshop this week, it seems appropriate to review briefly the history of the activities on low-cost extrusion cooking, note the current status of our work, and indicate what we hope to accomplish in the future. While it's a pleasure for me to do this, I also feel a little uncomfortable since most of the principal persons involved in LEC development are here in the workshop, and many of you listening to me now know certain parts of the story of LEC better than I. Accordingly, if when I'm through you've noted some discrepancies in my story, please speak out and set the record straight, for this is your story and you know it best.

While extrusion cooking as a technology goes back quite some years, the concept of low-cost extrusion cooking, LEC as we've come to call it, is not much more than 10 years old. As I understand it, LEC had its origins in the concept that farmers could, under some conditions, extrusion-cook soybeans on the farm and feed them directly to livestock more economically than sell their beans to soybean crushers and then rebuy the defatted soybean meal for feed. I believe the merits of this scheme hinge heavily on the relative costs of soybean oil and soybean meal, and on certain other factors which vary sufficiently to cause the economics to shift about. But regardless of this, some innovative and pioneering men sought to develop the concept, and as a result, certain inexpensive, mass-produced extrusion cookers were developed which were capable of cooking soybeans and inactivating the growth-inhibiting enzymes that prevent their direct use for animal feed or for human food.

One of those pioneers, Mr. Wayne Fox, President, Triple F Company, Des Moines, Iowa, is here with us to participate in the workshop. Mr. Fox's work in the 1960's led to the development of a simple extruder for dry-cooking soybeans. Mr. Fox sold his first machine in September 1969. Subsequently his company's machines have gone through a number of modifications, and to date several hundred of Trible F's InstaPro extruders have been sold. Although many of these are used for production of new feed products, even today the machines are used actively for cooking soybeans for feed use. During the week perhaps Mr. Fox will give some insights about recent developments with the InstaPro extruders.

About this same time the Brady Farm Division of Koehring Company entered the market with their Brady crop cooker, also a simple, inexpensive extruder designed specifically for cooking soybeans. The Brady Model 206 is intended specifically for on-farm cooking of soybeans; it is designed to receive power directly from a farm tractor through a power take-off and comes equipped with wheels like many other farm implements. The Brady Model 2160 has the same extrusion capabilities but is designed as a stationary unit with an electric motor attached directly to the extruder, a design lending itself more to small factory operations. These Brady machines, like the Triple F InstaPro extruder, were successful and effective for cooking soybeans, and several hundred were sold for that purpose.

These two machines were unique in that they applied the principles of extrusion cooking but at the same time were designed for low cost and inexpensive mass production. They were purposely engineered to be simple to operate so that farmers and small feed mill operators could run them without elaborate skills or training. They were self-contained and required no elaborate or expensive accessories like steam generators or driers since they operated as "dry" extruders. At the same time, they had a reasonably large output of 500-1,000 pounds per hour. All in all, these machines seemed to have many good features which attracted the attention of food technologists at AID and USDA and, quite independently, others like Pedro Bleyer in Bolivia, whom you'll hear from later in the program.

The primary reasons these low-cost extruders were of interest to us in government was that for several years we had seen and supported a growing interest in extrusion-cooked foods around the world. Extrusion cooking had caught on as a very effective, inexpensive way of making a variety of food products such as precooked cereals like the processed corn meal used in the children's foods CSM and ICSM; full-fat soybean flour used as a fortificant in blended foods; textured vegetable protein used as an inexpensive meat substitute or extender; puffed snacks and breakfast cereals; and certain specialty products such as milk extenders.

I believe it would be appropriate at this stage to acknowledge the outstanding contributions of Mr. Oak Smith and his colleagues of the Wenger Company, Sabetha, Kansas, who through their promotional program, informed the world of the great value of extrusion cooking. Extruders provided by Oak Smith and by his competitors at Anderson IBEC and others were installed in developed and developing countries alike to make a broad spectrum of food products. Their machines as a class were very successful and still are, in that they produce massive amounts of high-quality food products at very low costs. The production scale models of these extruders churn out up to several tons per hour of cooked products, and even though the initial capital costs for the extruder and associated equipment are high, the unit costs of the product are extremely low due to the high throughput. Thus in situations where high production rates are needed, these extruders are ideal. I'm not exactly sure how to quantify the term "high production rate," but perhaps, speaking loosely, it might be 5,000-10,000 tons per year as a minimum.

But in many instances high production rates aren't needed. For example, in some situations, situations illustrated by most of the production programs which will be described at this workshop, only 500 to perhaps 2,000 tons per year are required. Clearly, under these circumstances production models of conventional extruders lose some of their appeal, since the extruder would be idle a very large share of the time. Depreciation and other fixed costs therefore would necessarily be concentrated in fewer pounds of output, and production costs would be high.

It was in this setting that AID and USDA first started to look at the food-producing potential of those LEC machines which had been originally designed for cooking soybeans for farmers to feed to livestock. The idea was that if these simple, inexpensive, relatively low-capacity machines could make food-grade products like precooked corn meal, full-fat soy flour and TVP, they might well have useful low-volume applications where their larger cousins, the conventional extruders, were inappropriate because of their high capacity and corresponding high capital cost.

In March 1972, USDA arranged for exploratory tests of the Brady extruder in which soybeans and corn meal and mixtures of the two were extrusion-cooked and evaluated for food applications. The tests were considered highly successful in that the analyses of the products and the potential system economics were favorable. As a result, AID decided to pursue the evaluation further and to seek out useful applications of this type of machine.

I would like to point out here a facto which influenced AID and USDA's role in st ing and promoting LEC technology. In 1972 LEC's were terribly inexpensive, around $3 for a Brady extruder. The profit margin pe machine was therefore only a relatively fe dollars, and many machines had to be sold order to provide satisfactory business pro The number of machines which might be requi for food production has always been an unk factor, but no one, particularly in the ear days, expected extremely large numbers to b sold for food applications. Accordingly, there was not much of a profit incentive fo extruder manufacturers to test out and deve this market--the financial incentives just didn't justify it.

On the other hand, AID and USDA had a m date to identify, develop and make availabl to developing countries new technologies fo producing low-cost, nutritious foods. In ou view, LEC technology had the potential to be such a technology. Therefore, since it was not feasible for private companies on their own to explore food applications of LEC, and it was within government's mandate, we took the initiative.

The first step taken by AID and USDA was to make test machines available to institutions around the world for testing and evalu tion. For this purpose Koehring Company loaned us three extruders. One was sent to the Institue of Nutrition for Central Americ and Panama (INCAP) in Guatemala, where Dr. Ricardo Bressani has conducted its evaluation. The second was sent to CARE in Indonesia, where eventually the machine was purchased by CARE and a replacement machine sent to the Philippine Women's University in Manila for evaluation by Dr. Ignacio Pablo. You'll learn about both of these testing programs later in the program. The third machine was sent to the East African Industrial Research Organization (EAIRO) in Nairobi and subsequently forwarded on to Pakistan where it is now with the Pakistan Council on Scientific and Industrial Research (PCSIR).

The idea of this part of the program was to give technologists and administrators an opportunity to see LEC equipment in operation, to evaluate the products, and hopefully, to see opportunities where the technology might be used to make food products in their own countries. The program was successful in that use of these machines did contribute to decisions in several countries to proceed with use of the technology. For example, representatives of the Government of Tanzania observed the EAIRO machine's operation, made samples which were evaluated in Tanzania, and subsequently proceeded with the National Milling Corporation (NMC) weaning food factory, which we'll see and hear much more about later this week. The INCAP machine has also contributed to decisions on use of LEC machines. A group from Guyana visited INCAP to study LEC operations and subsequently after also visiting the PRONUTRE and CARE people in Costa Rica, elected to build a new weaning food factory using LEC technology in Georgetown. Also, INCAP has worked closely with representatives from Honduras and, as we'll hear later, the two groups are currently developing plans for a new factory in Honduras.

In the early stages of the testing program it became evident quickly that our knowledge of low-cost extrusion cookers was inadequate. To remedy this and to provide a site for research, a source of expertise in LEC technology and a base for technology transfer, in August 1974 AID and USDA entered into a contract with Colorado State University. This contract and subsequent extensions under the leadership of Drs. Jud Harper and Dick Jansen have for the past 4½ years represented the major AID/USDA input into the program. CSU installed a pilot plant with both Brady and Triple F extruders on the CSU campus and made a broad study of the capabilities and limitations of LEC machines. CSU engineers have developed plant designs for factories in Sri Lanka, Costa Rica, Guyana, and here in Tanzania. They've developed and tested manufacturing procedures, quality control tests and training manuals, and they've assisted with plant start-up and operator training around the world. I believe many of you have met CSU's staff as they've traveled around the world, including not only Jud and Dick, but also their engineering staff of Ron Tribelhorn, Joe Kellerby, David Cummings, and, in the early days, Marv Stone. As an additional important part of their program, CSU arranged to be an information dissemination center for LEC technology. This workshop and the earlier one held at CSU in June 1976 were organized by CSU's David Wilson. As you can see, CSU's role in technology evaluation, development and transfer has been, and hopefully will continue to be, a vital one.

In addition to the two program elements already cited (that is, the testing program where LEC machines were made available for evaluation and the CSU-based technology development and transfer program), there has been one other major element, that of technology demonstration. This element has involved the installation and long-term operation of LEC factories to give proof that the technology is indeed viable and can be applied with confidence in developing country settings.

This part of the program has not been undertaken as a U.S. initiative, but rather as a response to requests from developing countries and in cooperation with institutions within those countries. Basically it arose because certain groups said they wanted to build LEC food factories and asked AID/USDA/CSU technical and financial assistance for doing so. We agreed to provide the assistance, first because the factories made sense and deserved support, but also because operation of the factories and collection and analysis of factory records could constitute a demonstration of LEC performance that would be helpful to others interested in considering the merits of using LEC technology. The sites that sought technical and in some cases financial assistance from AID/USDA/CSU and serve as demonstration sites for the technology include Sri Lanka, Costa Rica and Tanzania.

The Sri Lanka factory was installed and started in early 1976 and has been operating more or less continuously since that time under the administration of CARE. It produces a precooked mixture of locally-grown corn and soybeans which is used as an ingredient in making a weaning food called Thriposha. Jay Jackson, who is now with CARE/Costa Rica, his colleague Dr. De Mel and others in Sri Lanka were largely involved in putting this plant in operation. A new, larger plant is now being built in Colombo, and I believe Earl Goodyear and Dr. De Mel will be giving us an overview of this total operation.

The Tanzania factory, which we'll all see this week, is designed to produce a precooked corn-soy-milk blend as a weaning food for child feeding. The factory is operated by National Milling Corporation, a public sector company, and has been producing since last May. NMC and others will be telling us about the plant and showing it to us this week.

The Costa Rica factory has been built by CARE/Costa Rica and is designed to produce both corn-soy-milk and full-fat soybean flour which will be paid for and distributed by the Government of Costa Rica. The project to build and operate the plant and a companion project to develop local production of soybeans were the outgrowth of work by Kurt Bachmann, who was Director of CARE/Costa Rica until retirement last summer. The plant itself is completed and should start up sometime next month.

Later this week Ron Tribelhorn will discuss the kind of information we hope to obtain from these factories to make available to those interested in extrusion cooking technology. It will include information on cost, performance and reliability, product quality, and a range of other characteristics. We are hopeful that the workshop setting will lead to inputs from any or all of you to round out the evaluation protocol.

I haven't covered all aspects of the past and current program and the related activities, but during the course of this week you'll have an opportunity to hear directly from the people involved in the programs. In addition to the topics I've mentioned, you'll hear from several people about activities to develop commercial retail markets for LEC products, including subsidized weaning foods in Guyana and marketing studies for Thriposha in Sri Lanka. You'll hear about breakfast cereal-type products produced with an LEC system in Bolivia and sold to consumers through retail stores. You'll hear about instant pea soup made by the Pronutre Company in Costa Rica and about the production of soybean flour by the Center for Technological Research and Assistance in Mexico. You'll hear about the work of Meals for Millions in Korea and of Mark and Hank Sterner on another LEC machine designed and developed by Mark and Hank. You'll also hear from Prof. Amara Bhumiratana of Thailand and Robert Nave of India about work on LEC in those countries. I believe it will be a full and informative week, and I hope we'll all get up-to-date on what has taken place with LEC.

But just as important, I hope we will also learn more about where we should go from here--what we should do in the future to utilize all the work of the past, and to take advantage of the LEC as a useful new technology.

From AID and USDA's present perspective we are now coming to the end of a technology development phase and are entering a new technology application phase. The technology development phase has been one in which we've learned some of the important uses of LEC technology and reduced them to practice on a limited scale. The technology application phase will be one in which the technology will be spread and utilized on a large and beneficial scale. Obviously, both are now going on concurrently. But we hope that within the next year the first phase can be reduced to a minor activity, and the second phase can be increased to a major activity.

In shifting gears from phase one to phase two, we believe there should be and will be an accompanying major change in the AID/USDA role in the LEC program. Although it's not yet clear what AID and USDA's new role will be, we are hopeful that the major role in applying LEC technology will be taken by some other organization, one that is specifically designed and mandated to provide this type of function. What we believe might make sense is for an organization with suitable skills and suitable facilities to offer LEC system design, procurement, and training services on a self-sustaining fee basis. We believe such an organization could also publicize and promote LEC as needed and perhaps carry on a limited amount of R&D to sustain progress on development.

CSU has been considering the establishment of a Technology Transfer Center which could serve all these purposes. I believe this might have merit. Perhaps during this week those of you who have ideas on this score could advise CSU as to what you think of the idea or suggest alternatives. This is a matter that affects us all, and we should give it serious consideration.

In the meantime, CSU, as well as USDA and AID, will continue to provide technical assistance for those who are already involved in development and application of LEC and also for others who might wish to explore its use.

I look forward to a useful week of information exchange and discussion. And I hope you all enjoy the workshop.

LEC* Technology: Where Does It Fit?

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PREFACE

I have two preliminary remarks before I begin. First, I hope in this workshop we can recapture what I felt was the most beneficial part of our workshop at Colorado State University in 1976--an honest interchange among all participants with an open attitude toward questions and responses from the audience. I am hoping we can rekindle that spontaneity which I think is essential for a workshop of this type.

Second, the paper I have prepared is a direct result of a question that Mert Cregger asked at our first international workshop. The point he made was the need to maintain perspective as we consider the alternative methods of producing nutritious foods. We need to have an understanding of those alternatives, how they fit together and their relative costs and capabilities so that people who are in decision-making roles can have that information available when they are making these types of decisions.

INTRODUCTION

Over the years, interest in producing nutritious food blends for weaning foods, supplements for pregnant and lactating mothers and for feeding school children or other populations with high nutritional requirements has been substantial. Because of cost and availability, nutritious foods for the above purposes can best be manufactured from a mixture of cereal in combination with a proteinous material, legumes or oil seed. Such foods are often called blended foods and contain 16% protein, having a quality approximately equivalent to milk protein casein, fat sufficient for an energy level of 400 kcal/100 kg and vitamins and minerals necessary for good nutrition. Examples of such blended foods are Title II commodities such as CSB (corn/soy blend), WSB (wheat/soy blend), CSM (corn/soy/milk), etc., which have been distributed through the U.S. Food for Peace Program.

Work at Colorado State University over the past three years has focused on the use of simple low-cost extrusion cookers (LEC's) as a method for combining and cooking locally grown cereals and legumes into nutritious blended foods in less developed countries (LDC's). This work has progressed through various stages including testing, evaluations and demonstration plant design, construction and operation through working arrangements with host countries and private volunteer organizations (PVO's). Before starting this effort, economic analyses were made which indicated the LEC technology was a viable economic alternative for low-cost manufacture of nutritious foods. The results of our work to date have concurred with these original assessments and have sharpened our ability to make meaningful comparisons between processing alternatives available to produce blended foods.

Comparison of alternatives is always difficult, and the results are as numerous as the number of individuals involved in the comparisons. The reason for some divergence in results is due to the fact that no two systems will produce identical products--which causes the evaluator to draw some "apples vs. oranges" comparisons. To minimize the questions or misunderstandings in the analysis reported here, all assumptions made to complete the comparison, along with the justifications, are clearly stated. In addition, the author spent considerable effort gathering first-hand cost and performance figures from the manufacturer and users of alternative processing equipment so that the information presented would be both factual and up-to-date.

WHY COOK BLENDED FOODS?

All the alternative processes compared are systems which will precook and instantize the cereal and proteinous ingredients in blended foods. It is therefore necessary to first justify the economic, nutritional and food safety aspects of these processes. The at-home production of nutritious foods equivalent to a precooked blended food is possible, so it could be argued that such commercial processes only add to the overall unit price of the food. Since cost is a pertinent factor in food availability to vulnerable populations in LDC's, then why aren't small-scale, labor-intensive systems found in the home more beneficial to the consuming population than a product which has received a substantial amount of preprocessing in a small-scale industrial environment?

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*Low-cost extrusion cooker

The advantages of processing, precooking and producing nutritious blended foods by a food industry in a LDC were first listed by Smith (1967, 1969). This summary of advantages of centrally processed foods borrows heavily from his list but adds some additional factors and changes the emphasis on others. The advantages are:

1. Cereal and protein materials can be thoroughly dehulled before incorporation into the blend. Dehulling is necessary for ingredients fed to infants to reduce bulk and increase caloric density.
2. The starch portion is fully cooked (gelatinized) and the protein partially coagulated to enhance digestibility.
3. The inactivation of thermally-liable growth inhibitors and anti-palatability factors in oil seeds and pulses is accomplished, minimizing cooking which would normally be required in the home.
4. Rapid destruction of lipases and oxidases greatly enhance storage stability of the processed product.
5. Creation of a pleasant cooked flavor to improve palatability and acceptability.
6. Central fortification of the product with a prescribed blend of vitamins, minerals and freshness preservatives.
7. Reduced fuel cost associated with the normal lengthy cooking requirements for pulses or oil seeds. Because only small batches of food can be prepared at home, heating efficiency of the cooking container is low, leading to increased fuel requirements for cooking when compared to those in a food processing plant.
8. Shelf-stable products which can be prepared as needed, assuring the availability of nutritious foods for the population requiring them.
9. Instantized products which can be prepared quickly in a food preparation center with a minimum of equipment or time.
10. Sanitary products free from contamination with bacteria and molds.
11. Availability of shapes and textures to increase acceptability and interest in eating nutritious foods.
12. Reduces long cooking times which lower the vitamin content and the nutritive value of the food constituents.

Once the desirability of producing nutritious blended foods at a central location has been established, then there needs to be a careful look at the location of the processing plant. The CSU project has been evaluating systems suitable for location in the LDC, where the nutritious food product will be consumed, for the following reasons:

1. Enhance utilization of locally-grown protein and carbohydrate food resources.
2. Serve as a focus for the development of small-scale industry and employment in the LDC.
3. Reduct transportation costs associated with movement of manufactured goods over long distances.
4. Formulation and processing of products to meet local tastes and customs.
5. Minimize packaging costs required, since products will be consumed locally and relatively quickly.

The comparison of a variety of processing alternatives which will produce a precooked blended food in an LDC environment is given below.

ALTERNATIVE PROCESSING SYSTEMS AVAILABLE

Two basic types of blending, precooking and drying systems have been used for the production of nutritious blended foods. They are systems which employ an extruder or drum dryer as the principal piece of processing equipment. These two systems differ fundamentally as shown in Table I.

Within the area of extruders, there is a wide variety of commercially-available equipment. The extrusion equipment differs on the basis of the mechanical features, but the basic difference can be categorized most easily by

Table I. Comparison of Characteristics of Extruder and Drum Dryer Systems
Used to Prepare Precooked Blended Foods

Extrusion Systems	Drum Dryer Systems
1. Mixes and cooks ingredients in one high temperature/short time step (< 200 sec).	1. Ingredients are cooked in tanks using steam and relatively long residence times (30 min).
2. Relatively low-moisture process (16-35%), so cooked product needs little redrying.	2. Product cooked in a 60-80% moisture slurry before it is dried.
3. Product drying/cooling is achieved using a drier with hot air since the product is a hot-rubber-like semi-solid when it leaves the extruder.	3. Product drying is done on the surface of heated drums because it is a high-moisture fluid material.
4. Finished products can be in the form of expanded pellets or chips which can be ground to a precooked flour if desired.	4. Product is a flat soluble flake.
5. High temperature/short time processing maximizes beneficial effect on food ingredients while minimizing detrimental effects of overheating.	5. Excessive product heating can cause denaturization of desirable food constituents and reduction of the nutritional values of the product.

the moisture of the product which is being processed. Table II shows such a classification of extrusion equipment. The low-moisture extruders are normally characterized by low capital cost, high mechanical energy inputs, higher maintenance costs, little or no product drying and limited product capabilities. Here the exception would be collet extruders, used to manufacture expanded cereal-based snacks such as corn curls, which are characterized by high capital costs and will not be considered further. The opposite statements can generally be made about the high-moisture extruders.

COST ANALYSIS METHODOLOGY

Almost endless comparisons can be made between systems which can successfully cook blends of cereal and protein sources, but the most significant of these comparisons deal with cost. Costs are normally analyzed on the basis of capital costs, or the money required to finance the purchase of equipment, construct the plant and fund the initial operation until it becomes self-supporting. Since capital, especially foreign exchange capital, is limited and expensive in LDC's, these costs need to be carefully analyzed.

Operating costs are the second form of cost comparisons which are essential for evaluating processing alternatives. One major aspect of operating costs is ingredient costs, which will remain the same regardless of the processing system, and so are ignored for the purpose of this analysis. Operating costs are then the cost of utilities (electricity, fuel, water, steam), the recovery of initial invested capital, maintenance and labor.

A number of assumptions had to be made in order to confine the scope of the analysis so that meaningful comparisons could be made without clouding the points which differ between the systems being analyzed. In all instances, these assumptions are clearly stated so that the individual using these data can determine if they correctly describe the circumstances of a particular location. If they don't, hopefully it will be possible for a user to provide a more appropriate set of inputs which can be used with the basic data given to develop meaningful comparisons for a specific location.

To focus on the differences between the processing alternatives available, cost analyses were made only on the equipment used for product cooking and cooling/drying. It was assumed that the raw ingredient storage, cleaning, dehulling, grinding, packaging, and warehousing systems were similar for all systems and varied principally on the basis of local conditions and/or the scale of operations. In

Table II. Classification of Extrusion Equipment on the Basis of the Moisture Content of the Feed Ingredients

Feature	Low Moisture	Intermediate Moisture	High Moisture
1. Ingredient moisture	1. M $\leq$ 20%	1. 28% > M > 20%	1. M $\geq$ 28%
2. Source of input energy	2. All energy input from viscous dissipation of mechanical energy input	2. About half of energy input comes from viscous dissipation of mechanical energy input, other half comes from steam injection	2. Majority of energy comes from steam injection with very little energy coming from the conversion of mechanical energy to heat
3. Mechanical energy	3. 0.10 $\frac{\text{kW - hr}}{\text{kg}}$	3. 0.04 $\frac{\text{kW - hr}}{\text{kg}}$	3. < 0.02 $\frac{\text{kW - hr}}{\text{kg}}$
4. Product drying	4. None required. Product cooling results in 6% moisture loss	4. Some product drying required to remove moisture in excess of 12% in finished product	4. Extensive product drying is required to reduce finished product moisture
5. Product shape	5. Minimal number of shapes available beyond highly expanded pieces or flakes	5. Many product shapes available	5. Maximum flexibility of product shapes and textures
6. Product density	6. Low-density expanded product	6. Moderate density	6. Range of density possible
7. Ingredients	7. Feed blends should contain > 7% fat	7. Few limitations	7. Few limitations
8. Capital cost	8. Low to high capital costs	8. Moderate to low capital costs	8. Moderate to high capital costs
9. Maintenance costs	9. High - \$1.20/MT	9. Moderate \$0.50 - 0.60/MT	9. Low to moderate \$0.40 - 0.50/MT
10. Manufacturers	10. Brady, MFM, Insta-Pro, Collet extruders (Manley and Dorsey-McComb)	10. Anderson-IBEC, Wenger	10. Anderson-IBEC, Bonnot, Sprout-Waldron, Wenger

the case of the extrusion system, a schematic of the components involved in the analysis is shown in Figure 1, consisting of the extruder with a preconditioner, a cooler/dryer and a boiler. Not all of these pieces are required for each type of extrusion system considered, and the nature of each system is so noted in the analysis. The process using the drum dryer is given in Figure 2.

The specific assumptions used in the calculations are listed in Table III. The labor rates reflect our collective experience in LDC's and may change drastically with location. It was assumed that skilled labor was required to operate equipment having a capacity of < 1.5MT/hr, while semi-skilled labor was suitable for smaller systems.

Table III. Assumptions Made in Estimation

---

1. All equipment costs show purchase prices in the United States. No overseas delivery costs or taxes are included.

2. Cost estimates (capital and operating) were done for the processing operations involving cooking, drying and/or cooking. The processing equipment included in these steps are shown in Figure 1 and 2.

3. The cost of raw material storage, handling, cleaning, dehulling, blending, packaging or warehousing is not included in the estimates. These costs should be similar between systems of equal capacity.

4. Cost of building and land required for the plant are not included.

5. Labor costs were estimated using wages for:

semi-skilled operators	\$ 0.50/hr
skilled operators	\$ 1.00/hr
highly skilled operators	\$ 1.50/hr

6. Utility rates used in estimates were:

electricity	\$ 0.04/kW-hr
steam	\$10.00/100 kg
fuel oil	\$ 0.15/liter
water	\$ 0.10/m^3

7. Yearly equivalent costs of capital were determined assuming money draws interest of 10%/year and the equipment has a useful life of 10 years with no salvage value at the end of the period. The capital recovery factor used

$$\frac{i(1+i)^n}{(1+i)^n-1} = 0.16275$$

8. Plant operations were considered to be 24 hour/day, 5 day/week for a total of 6000 hour/year.

9. Drying requirements were estimated by assuming that 6% moisture was lost by flash-off and cooling occurring at the die. After this loss of moisture, the quantity of water removed during drying was:

$$X = \frac{\dot{m}(M-0.12)}{(1-M)}$$

where:

X = quantity of water removed kg/hr

$\dot{m}$ = product rate, kg/hr

M = moisture (fraction) in product after loss of 6% due to flash-off and cooling

0.12 = moisture (fraction) of raw ingredients and finished product

10. Drying required 810 kcal/kg of water removed.

11. Direct steam injection into the product provided 540 kcal/kg steam added.

12. Installation costs were 10% of capital cost for simple systems requiring little plumbing and increased to 25% for systems requiring substantial plumbing and other installation complexities.

13. For the extrusion systems, the electricity requirements for all motors in addition to the extruder drive were included in the total electrical costs shown on Table VII.

Utility rates greatly influence the analysis and the conclusions drawn. Obviously, no one set of average utility rates accurately reflects the prices in a specific location which are governed mostly by the tax structure found in a specific country and transportation costs. The values used do reflect the current price of oil and the relative generating efficiencies for each form of energy and are shown in Table IV.

Table IV. Relative Energy Costs

	Cost	\$/10^6 kcal
Fuel oil	\$ 0.15/ℓ	16.70
Steam	\$ 10.00/100 kg	18.00
Electricity	\$ 0.04/kW-hr	46.50

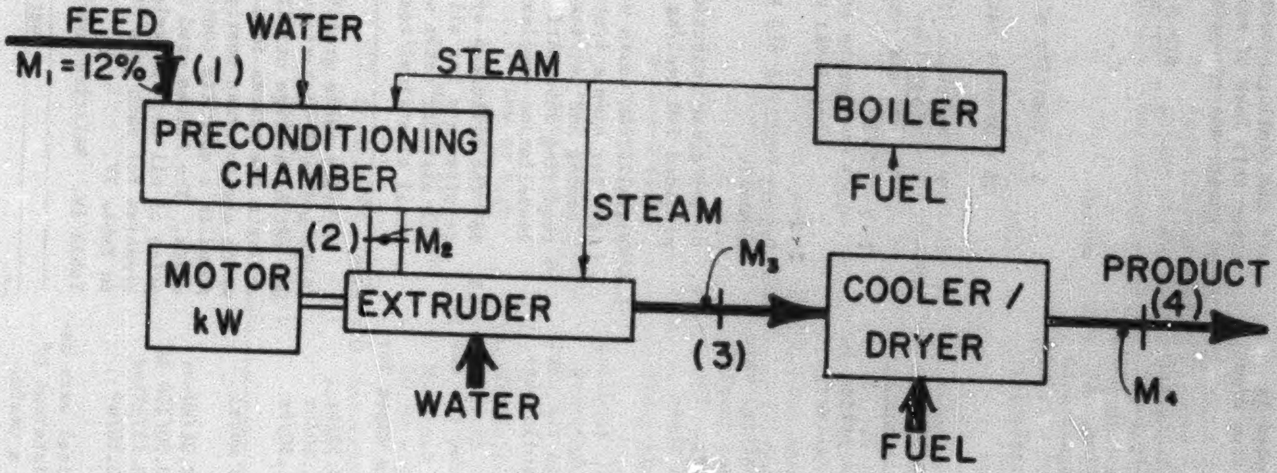
FEED
M₁ = 12%
(1)
WATER
STEAM
BOILER
FUEL
PRECONDITIONING CHAMBER
STEAM
(2)
M₂
MOTOR kW
EXTRUDER
WATER
M₃
(3)
COOLER / DRYER
FUEL
PRODUCT
(4)
M₄

Figure 1. Schematic of Extrusion Processing System Showing Inputs and Critical Parameters.

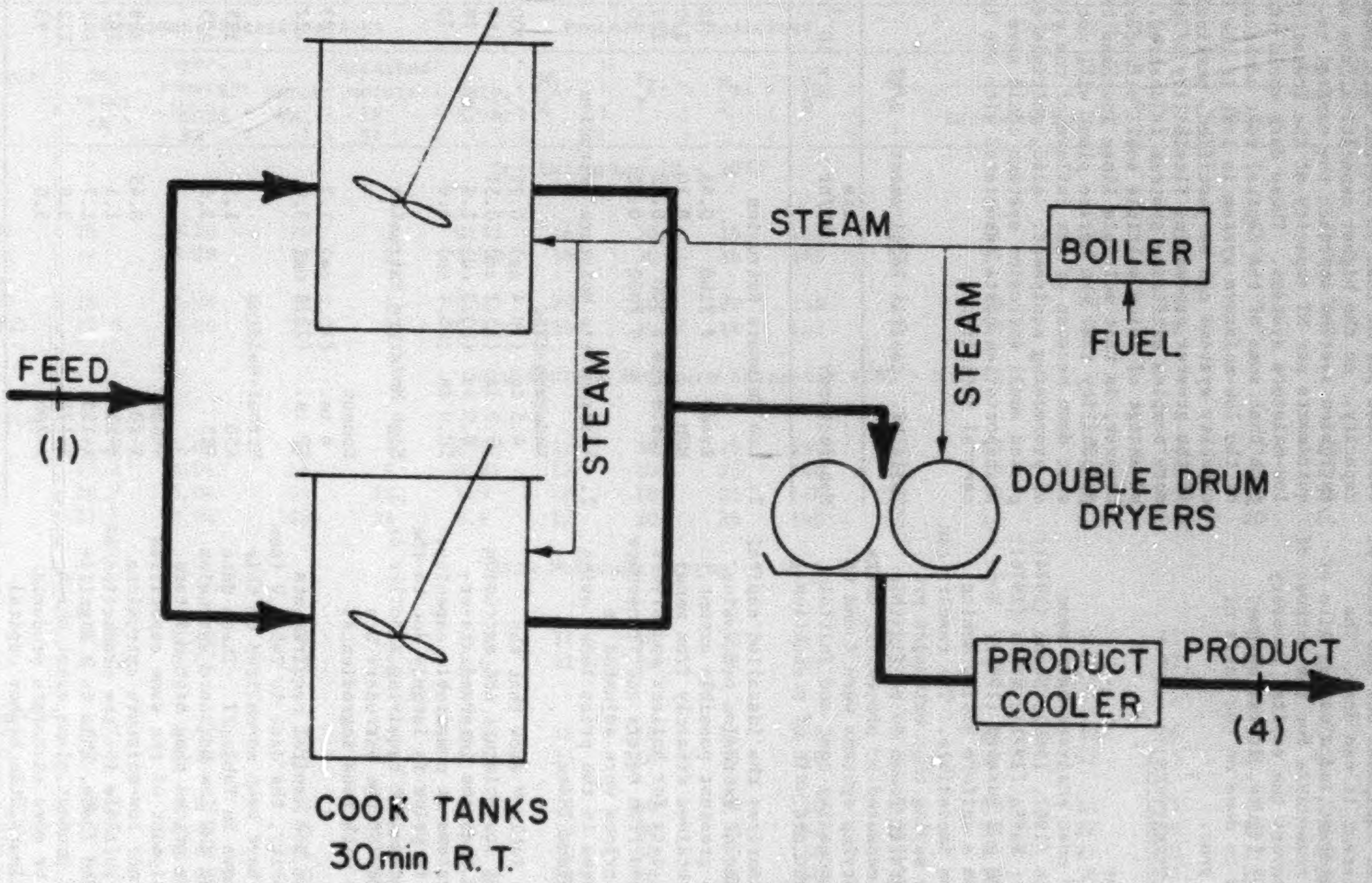
FEED
(1)
STEAM
STEAM
STEAM
BOILER
FUEL
DOUBLE DRUM
DRYERS
PRODUCT
COOLER
PRODUCT
(4)
COOK TANKS
30min R. T.

Figure 2. Schematic of Drum Dryer Processing System Showing Inputs and Critical Parameters.

The capital expended at the initiation of operations must be recovered as part of the operating cost. Capital recovery considers the useful life of equipment and the value of money or the interest it can draw. The values of 10% interest and a useful life of 10 years appear reasonable for the purpose of analysis. To convert the capital recovery cost to an hourly figure, it was assumed processing would be done on the basis of 6,000 hours per year.

COMPARISON OF ALTERNATIVES

Extrusion Systems

A number of cost analyses have been published: Smith (1967, 1969); Stone (1974); Anonymous (1977); Buffa (1971); Mitra (1976); and de Muelenaere and Buzzard (1969). None of these was done on a uniform basis, making direct comparison impossible. The results can be summarized by saying that extrusion processing was generally found to be flexible and low-cost as measured by processing costs in $/MT. Drum-drying systems were found to have a higher processing cost and initial capital investment per unit of production.

Table V summarizes the installed capital costs for a number of extrusion processing systems. To the greatest possible extent, cost data were obtained directly from manufacturers. Cost data for boilers and dryers were also obtained from Peters and Timmerhaus (1967), and the prices were adjusted to reflect the changes in the price index using the Marshall-Stevens Index.

The data in Table V show that the installed cost of low-moisture LEC extrusion systems is lower than the intermediate-or-high-moisture systems at comparable capacity. This difference in price is largely due to the low-moisture systems not requiring a boiler or dryer. Capacities of the extruders are nominal and vary with feed ingredients.

To determine how capital requirements change with capacity, the data in Table V (see following page) have been normalized on this basis and are shown in Table VI. These data again reveal that the low-moisture extrusion systems are lower priced than high-moisture systems when equipment of the same capacities is compared. Since low-moisture extrusions have been found suitable for the production of nutritious blended foods, this is a significant result. If product plans exist which call for shaped or more elaborate products than precooked flours, the higher capital investment in wet extrusion systems capable of making these products is necessary.

Another important result shown in Table VI is the effect of capacity on capital requirements. Clearly, higher capacity systems cost less per MT than do systems with lower capacity. At the higher capacities, the wet extrusion systems approach the capital requirements per MT capacity of the lowest cost low-moisture systems. These data would indicate that some of the capital cost advantage of the low-moisture system is lost if the higher capacity systems can be justified, particularly if the greater processing flexibility of the more complex extrusion systems is desired. One advantage of using multiple small extruders, however, is that multiple lines increase the probability that the entire plant will not be shut down because of the failure of one piece of processing equipment. Also, multiple dispersed small extrusion systems could save transportation costs associated with one large central facility.

Table VI. Capital Requirement - $/MT

Manufacturer		Rate MT/hr	$ x 10^{-3}/MT
1. Low Moisture Extrusion			
Brady	# 2160	0.45	58
MFM		0.10	230
Insta-Pro	# 500	0.22	172
	# 2000	0.82	60
2. Intermediate Moisture Extrusion			
Anderson-IBEC			
4.5 in.	(10.4 cm)	0.22	300
6.0 in.	(15.2 cm)	0.51	164
8.0 in.	(20.3 cm)	1.9	79
10.0 in.	(25.4 cm)	3.6	73
3. High Moisture Extrusion			
Bonnot			
6 in.	(15.2 cm)	1.3	183
10 in.	(25.4 cm)	3.0	122
Sprout-Waldron			
450		1.2	175
775		3.6	105
Wenger			
X-20		0.45	268
X-25		1.1	147
X-155		1.7	141
X-175		3.0	112
X-200		5.0	93

Table V. Capital Cost of Requirement for Extrusion System Shown in Figure 1.

Manufacturer	Equipment Specifications				Processing Conditions						Cost ($\$ \times 10^{-3}$)					
	Diameter cm	Spec. energy kW-hr/kg	Motor kW	Attached motors kW a/	Rate, MT/hr	M_2, %	T_2, %	M_3, %	T_3, %	M_4, %	Capital				Installation	Total
											Extruder	Boiler	Dryer/cooler	Misc.		
Dry Extrusion ($M \leq 20\%$)																
Brady -																
model 206	15	0.10	75	3	0.45	16	30	16	165	10	11	--	10	3	2	26
MFM	--	0.08	19	2	0.10	16	30	16	165	10	14	--	5	2	2	28
Insta-Pro																
model 500	10	0.08	38	2	0.22	20	30	20	150	12	10	--	15	3	3	38
model 2000	14.0	0.08	75	3	0.82	16	30	16	165	10	30	--	12	4	3	49
Intermediate Moisture Extrusion ($28\% > M > 20\%$)																
Anderson/Ibec																
b/4.5 in.	11.4	0.04	19	5	0.22	12	30	25	140	12	30	8	12	3	13	66
6.0 in.	15.2	0.04	38	8	0.51	12	30	25	140	12	28	13	18	8	17	84
8.0 in.	20.3	0.04	94	20	1.9	12	30	25	140	12	38	29	43	15	25	150
10.0 in.	25.4	0.04	188	34	3.6	12	30	25	140	12	94	43	63	20	44	264
High Moisture Extrusion ($M \geq 28\%$)																
Bonnot																
6 in.	15.2	0.02	56	15	1.3	32	40	32	145	12	110	24	45	12	48	239
10 in.	25.4	0.02	113	25	3.0	32	40	32	145	12	160	35	92	18	61	366
Sprout-Waldron																
model 450	11.4	0.015	38	15	1.2	35	110	35	140	12	82	30	46	11	42	211
model 775	19.7	0.015	113	34	3.6	35	110	35	140	12	107	62	125	20	63	377
Wenger X-20	8.3	0.02	22	8	0.45	30	80	30	140	12	55	14	25	3	24	121
X-25	13.3	0.02	56	12	1.1	30	80	30	140	12	70	22	38	10	32	162
X-155	--	0.02	94	18	1.7	30	80	30	140	12	89	27	70	13	40	239
X-175	--	0.015	150	25	3.0	28	80	33	140	12	132	38	92	18	56	336
X-200	23.5	0.015	188	40	5.0	28	80	33	140	12	208	54	113	22	79	476

a/ Motors in addition to extruder motor.

b/ Anderson-IBEC equipment is capable of operating at higher moistures; when this is done, mechanical energy requirement is reduced.

Table VII shows typical operating cost for the various extrusion systems described in Table V. One striking fact is that all of the extrusion systems process the food at a relatively low cost. The most expensive system processing cost is 1.6¢/kg, while most are under 1¢/kg. Further examination of the table shows other economics at work and the relative trade-offs between:

1. Economies of scale where larger systems require less capital/MT capacity and more efficiently use labor, thus reducing its processing cost.

2. The large use of high-priced electrical energy for low-moisture extrusion against the cost of steam, fuel for drying and the increased capital requirements needed for high-moisture extrusion systems.

3. The higher cost of maintenance from increased wear with the low-moisture extrusion against the lower total equipment costs.

Each of these trade-offs is discussed in more detail below.

The economies of scale are again a factor when considering operating costs. The cost of producing a MT of product using the higher capacity equipment is clearly less than that associated with similar low capacity equipment. It is interesting to note that the low-cost Brady extrusion system will produce a blended food product more cheaply than most of the wet extrusion systems studied. Said another way, the Brady system will produce precooked food products with processing economics very similar to much larger systems which require large capital investment and which may be inappropriate for many LDC situations.

Under processing conditions which exist in many LDC's, the use of a relatively high-priced electrical energy source in a dry extrusion system seems to be justified when the cost of steam and fuel for drying the high-moisture extrudate, needed to reduce electrical energy consumption, is considered. Even with wet extrusion, the electrical energy consumption is high because of the increased number of electrical motors required to operate the pumps, blowers and conveyors associated with the boiler and dryer.

Low-moisture extrusion results in higher maintenance cost/MT because of the increased wear on the extruder parts. Low-moisture extrusion uses the viscous dissipation of mechanical energy, a form of friction, to produce the heat which increases wear. In the analysis, conservative estimates of maintenance costs were used, and actual experience may provide different results. Despite the increased maintenance, low-moisture extrusion systems can produce precooked blended food products competitively with larger and more sophisticated extrusion systems.

Drum Drying Systems

The capital and operating costs for a drum drying process are shown in Table VIII. For similar capacity systems the capital costs are more than double a comparable extrusion system. The reason for the high capital costs rests primarily on the high cost of the drum dryer, which has relatively low productivity because it dries slurries with low solids concentrations.

Table VIII also shows that the operating costs of drum drying systems are very high because of the large amount of water which must be removed by the dryer per kg of product. Therefore, steam consumption is very high and costly. Processing costs appear to be five or six times comparable extrusion processing costs. The drum drying process produces a soluble flaked product resembling many commercial infant food formulations, which may increase its commercial appeal but which is not warranted on the basis of costs or product performance.

CONCLUSIONS

1. Extrusion cooking systems have capital and processing costs which are substantially lower than comparable drum drying systems.

2. Low-moisture extrusion systems of the LEC variety have capital cost advantages over intermediate-or high-moisture extrusion systems having capacities less than 1.0 MT/hr.

3. The total energy and maintenance costs appear to be nearly equal for low- and high-moisture extrusion processes for equipment of comparable capacity.

4. For small capacity plants (<1MT/hr), LEC's producing low-moisture products have operating cost advantages over higher-moisture extrusion systems.

5. Plants requiring large capacity or manufacturing products with relatively sophisticated shapes and textures should consider the use of high-capacity, high-moisture extrusion systems.

Table VII. Operating Costs

Manufacturer	Rate	Labor	Utilities									Maintenance		Cost		
			Electricity		Steam			Drying						Capital	Total	$/hr
	MT/hr	$/hr	kW-hr/hr	$/hr	kg 1/ / kg	kg/hr	$/hr	Req. kg/hr	Fuel x 10^{-3} kcal/hr	Cost $/hr		$/MT	$/hr	$/hr	$/hr	MT
Brady Model 2106	0.45	0.50	48	1.92	--	--	--	--	--	--		1.20	0.54	0.70	3.66	8.13
MFM	0.10	0.50	8	0.32	--	--	--	--	--	--		1.20	0.12	0.57	1.51	15.10
Insta-Pro Model 500	0.22	0.50	20	0.80	--	--	--	5.1	4.1	0.07		1.20	0.26	1.03	2.66	12.09
Model 2000	0.85	1.00	68	2.64	--	--	--	--	--	--		1.20	1.02	1.36	5.02	5.91
Anderson-IBEC 4.5 in	0.22	0.50	13.8	0.55	0.08	19.4	0.19	19	15.4	0.26		0.60	0.13	1.79	3.42	15.54
6.0 in.	0.51	0.50	28	1.12	0.08	44.8	0.45	44	35.7	0.59		0.60	0.31	2.28	5.25	10.29
8.0 in.	1.9	1.00	96	3.84	0.08	167	1.67	164	133	2.22		0.50	0.95	4.07	13.75	7.24
10.0 in.	3.6	1.00	188	7.52	0.08	317	3.17	311	252	4.21		0.50	1.80	7.16	24.86	6.91
Bonnot - 6 in.	1.3	1.00	41	1.64	— 2/	120	1.20	245	198	3.31		0.45	0.58	6.48	14.21	10.93
10 in.	3.0	1.00	85	3.40	—	277	2.77	568	460	7.68		0.45	1.35	9.93	26.13	8.71
Sprout-Waldron																
Model 450	1.2	1.00	33	1.32	0.11	132	1.32	287	232	3.87		0.45	0.54	5.72	13.77	11.48
Model 775	3.6	1.00	88	3.52	0.11	396	3.96	862	698	11.65		0.45	1.62	10.23	31.98	8.88
Wenger X-20	0.45	0.50	17	0.68	0.10	45	0.45	71	57.5	0.96		0.50	0.22	3.28	6.09	13.53
X-25	1.1	1.00	34	1.36	0.10	110	1.10	173	140	2.34		0.50	0.55	4.39	10.74	9.76
X-155	1.7	1.00	52	2.08	0.10	170	1.70	268	217	3.62		0.40	0.68	6.48	15.56	9.15
X-175	3.0	1.00	70	2.80	0.11	315	3.15	615	498	8.13		0.40	1.20	9.11	25.57	8.52
X-200	5.0	1.50	115	4.60	0.11	525	5.25	1025	830	13.86		0.40	2.00	12.91	40.12	8.02

1/ Kgs steam injected into product per kg product.
2/ Steam used to heat product through jackets surrounding barrel.

Table VIII. Capital and Operating Costs for the Drum Drying Process Shown in Figure 2.

A. Equipment and Capital Costs

Rate MT/hr	Drying rate kg/M^2 hr	Steam press ATM	Size M^2	M_2 %	T_2 %	T_3 %	T_4 %	M_4 %	Attached motors kW	Tanks $	Broiler $	Drum Dryer $	Cooler $	Misc. $	Instal. $	Total $
0.5	20	10	25	60	85	130	40	5	25	11	64	80	8	25	44	266
1.5	20	10	75	60	85	130	40	5	55	13	80	190	12	45	68	408

B. Operating Costs

Rate	Labor	Utilities						Maintenance		Costs		
		Electricity		Steam		Water				Capital	Costs	
MT/hr	$/hr	kW-hr/hr	$/hr	kg/hr	$/hr	M^3/hr	$/hr	$/MT	$/hr	$/hr	$/hr	$/hr/MT
0.5	1.50	25	1.00	1300	13.00	1	0.10	1.00	0.50	7.21	23.31	46.62
1.5	1.50	55	2.20	3900	39.00	3	0.30	1.00	1.50	11.07	55.57	37.04

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The Progress of MAISOY in Bolivia

Pedro Bleyer Presser
MAISOY, Inc.
Santa Cruz, Bolivia

Ladies and gentlemen, distinguished members of the LEC family, and dear friends:

Over two years have passed since our last meeting at Fort Collins, and since then I am sure many of us have developed new ideas and new products.

These meetings are important, as we not only give information, but much more importantly, we receive it as well. I am grateful for this opportunity to report on our activities at MAISOY.

Marketing: The Public Sector

We have obtained a contract with the Ministry of Public Health for five years to supply annually 100 tons of Maisoy flour in a ratio of 70/30 corn/soya, extruded and micro-pulverized, packed in plastic bags (polyethylene and polypropylene) of 46 kilos each, at a price of U.S. $0.35/kilo.

The government already has paid the value of 300 tons, but the product's distribution is very slow because it is distributed by the Mother's Club in some infant programs.

Deliveries were as follows:

1976	56,660	kilos
1977	29,900	kilos
1978	141,403	kilos
	227,963	
1979	72,037	(to be delivered)
1979	100,000	(as per contract)
	172,037	Total

There are no prospects for an enlargement of the demand by the public sector.

Marketing: The Private Sector

With the theory of obtaining bigger benefits by placing the most sophisticated products in the private sector, we have investigated and issued new consumer products on a national scale with very interesting results. You will have the opportunity to sample some of them later.

Products

Our product, Flakes of Maisoy, was issued in three types: natural, sweet and (economy) scholastic.

Natural flakes - process: a mixture of dehulled corn and whole soybeans, 85/15, ground into flour and extruded.

Sweet flakes - process: a mixture of the natural type, adding for each 100 kilos 10 kilos of sugar before extrusion.

(Economy) Scholastic flakes - the sweet flakes packed in economy containers.

For containers we use thick polyethylene bags inside cardboard containers that contain 340 grams, trying to copy the American cereal containers. For the scholastic type, we use an economic thin polyethylene bag containing 35 grams and including a plastic toy. Sales figures are given in Table I.

Table I. Sales

			Unit	Kilos
Sweet Flakes - 340 grams				
1977	8,026 boxes	12/1	96,312	32,746
1978	3,231 boxes	12/1	38,772	13,182
Scholastic Flakes - 35 grams				
1977	3,918 boxes	144/1	564,192	19,747
1978	1,335 boxes	144/1	192,240	6,728

1/ The natural flakes were sold only in small quantities in the first three months of 1977. Subsequently, they were all used for the sweet flakes and their sales are reflected accordingly.

In 1977 we ran a very expensive publicity campaign on TV and radio and in newspapers. In 1978 we had only a modest amount in the newspapers and radio. Sweet and scholastic flakes enjoyed a big success because of the initial TV publicity. Now that the novelty has passed, we consider that a more realistic and stable level of sales has been established. We do not think that a new, expensive publicity campaign would even pay the cost of the publicity involved, let alone increase our sales.

In October 1978 we introduced new lines into the market to reach the low-income market. For these people, the product "Delicious Maisoy" will help solve their nutrition problem in an economical way by giving a good portion of proteins and energy to their children. Delicious maisoy is a mixture of 70/30 dehulled corn and whole soybeans, plus a vitamin mix containing:

Vitamin B_1	26.80 mg
Vitamin B_2	16.22
Niacin	193.34
Iron	169.34
Vitamin B_6	30.00
Vitamin A	100,000 I.U.

Prior to extrusion we add 10 kilos of sugar for each 100 kilos of mixture. After extrusion the product goes through a micropulveriser. It is then packed in cellophane-polyethylene bags of 150 grams each by an automatic thermoseal machine. In the first three months of production we have sold 1,000 bags of 140 grams at U.S. $0.25 each. Publicity has consisted of sending to each pediatrician in the country an explanatory letter about the product and, as a promotion, 15 bags. Because of its nutritional value, this is the most important product for us despite its very slow progress at the marketplace. It is not well known, and we cannot afford to mount an expensive publicity campaign. An analysis of the product appears in Table II.

Table II. Analysis of Delicious Maisoy
(per 100 g)

Calories	407
Proteins	17-20 g
Oil	6.55 g
Vitamins and minerals	344 mg
Fiber	2.64 g

Delicious Maisoy can be served in several ways:

1. For baby's bottle - for an 8 oz. bottle mix 2 teaspoons of Delicious Maisoy into water or milk, sugar to taste, and bring to a boil for a few seconds.
2. Super breakfast - a 150-g bag added to a liter of water or milk, cold or warm, sugared to taste, will give you five-to-six delicious cups.
3. Refreshment - boil water with cinnamon and clove, then add two or three teaspoons of Delicious Maisoy for each glass. Sugar to taste and add ice.
4. Snack - mix 7 teaspoons of Delicious Maisoy with 3 or 4 teaspoons of sugar. Ready to eat.
5. Pudding - add to a liter of boiling milk 150 g (one bag of Delicious Maisoy), keep boiling for 3 minutes until it becomes thick, then let cool. You may add some raisins, coconut, jam or fruits.

Another new product, Chicha of Maisoy, is Delicious Maisoy with cinnamon and clove flavors mixed in a micronizer before being packed. It is marketed in envelopes of 15 grams of cellophane polyethylene thermosealed by an automatic machine. In the first three months we sold about 100,000 envelopes of 15 grams, almost all in Santa Cruz, where the people are used to drinking a refreshment made of corn, cinnamon, clove and sometimes with a little bit of peanut added to improve the quality. In our case we add soya instead of peanuts. Our price is U.S. $0.075 for an envelope of one liter, and it is sold in the streets as a refreshment for U.S. $0.05 per glass.

We have advertised modestly on radio and in newspapers. In addition, the biggest publicity effort was at our stand of the XI International Exhibition in Santa Cruz at the end of September 1978. During ten days, more than 30,000 persons tasted our product there and bought about 50,000 envelopes of Chicha. The market for this product seems to be confined to Santa Cruz, because sales are very low in the rest of the country. A third product, Pito de Maisoy, is a mixture of 65% of the remainder of Maisoy flakes or the Delicious Maisoy micropulverized and 35% sugar. In the first three months we have sold more than 10,000 envelopes at U.S. $0.05. This is a traditional product in Bolivia, which makes us believe this year will see us reach an important sales level. There has been very little publicity in the newspaper. We have planned some publicity for February 1979, including a contest with prizes for those who will collect pictures of the 16 football players who played in the football game in Argentina.

Possibility of the Project

Investments - The investment in the Maisoy line, excluding the storage system that takes care mainly of the feed graded for fowl is U.S. $130,000 as seen in Table III.

Table III. Maisoy Investment

2 extruders	30,000
Buildings	30,000
Cleaning machine, hammer mill, dehuller machine, mixer, elevators, micropulverizer and micromixer	45,000
Automatic packing machine and other simple packing machines	25,000
TOTAL	U.S. $130,000

Sales figures are given in Table IV.

Table IV. Maisoy Sales

1976	U.S. $ 20,000
1977	U.S. $170,000
1978	U.S. $120,000

Profit - To the Maisoy project we do not charge any fixed costs, depreciation or electrical expenses; the animal feed factory absorbs these costs. In this way, the Maisoy line gives us a little profit.

Future Possibilities

The plant has two extruders with a capacity of 500 kilos/hour each. In 1978 we produced 141 tons of product, leaving one extruder in backup. We still had an available capacity of 859 tons of product, assuming a total capacity of 1,000 tons/year.

The history of similar products that enjoyed success, such as INCAPARINA in Guatemala, shows us that we need three basic conditions to be successful:

(1) A subsidy by a mother enterprise for a couple of years that will absorb all the expenses, as I have explained before.

(2) An adequately directed promotion from the public sector of the market to encourage consumption. INCAPARINA had it, but we didn't.

(3) Sales to government that help to promote the product. If we accomplish these three points our sales will grow, but the domestic demand still will not utilize our full production capacity.

We think that Delicious Maisoy especially can be very competitive in the international market due to the low cost of the corn and to the incentive for exportation currently available in Bolivia. That is the reason that we can offer our product in containers of polyethylene and polypropylene of 46 kilos at U.S. $300/ton FOB, with a range of transportation costs--depending on the ports--from U.S. $[illegible] to U.S. $80 per ton.

We suggest that others planning production and marketing efforts look for financial aid from international organizations to cover the cost of publicity of products such as Delicious Maisoy. They should study future projects with practical experiences in mind, especially when entering a market with similar products. And finally, they should attempt to interest the international organizations engaged in food distribution programs in using these products in their programs.

Discussion - Monday Morning

Moderator:

Dr. G. Richard Jansen
Department of Food Science and Nutrition
Colorado State University
Fort Collins, Colorado

Dr. Siegel:

My question is on the Brady Cooker Model 206 and 2106: are these extruders identical except for one's being stationary and one's being powered by tractor?

Dr. Harper:

They are identical other than the drive. One is driven by a tractor with a diesel engine, and the other one is typically driven by an electrical motor of the same capacity. There is one other minor difference: the 2106 is driven at a speed of 900-to-1000 rpm, and the 206 is at about 540 rpm.

Mr. Alvarado:

Mr. Bleyer, what percent of your product sales is to the institutional market, and how much goes to the retail market? The second part of the question is, what would happen if, after the five years, the government decides not to buy the product which you are at this time selling to them?

Mr. Bleyer:

Thank you for your question. In 1978 a total of 120 tons was made--20 tons for the private sector and 100 tons for the government. The second answer: after 1981 the contract with government will be finished at 100 tons. That is one of the ideas I am trying to tell the international organizations, namely, that if they want to help us, they can buy some products from us to export to other countries. I don't know in what way exactly, but that could be a very important help for us--because in our market I don't know how far we can go.

Ing. Clark:

With your product MAISOY in the box you are competing directly with Kellogg's in the same market, and that is not so good. Now, my question is, what is the difference between your product in price and Kellogg's, and what did Kellogg's do when you went into the market with that product?

Mr. Bleyer:

With the first product we produced after the one for the government, the idea was to make something that was well-known by the middle class of our country--and that is the idea of MAISOY flakes. We advertised the flakes in boxes on TV, and that worked very well. Sales started going up and up, and the first two or three months we had difficulty suppying the customers with enough packaged material to cover the market. Price was a big problem for us when we started. We can make the product much cheaper than $1.50, the price of MAISOY in the stores. We can sell it for perhaps half the price of Kellogg's corn flakes. In Bolivia, the same size box of corn flakes sells for 45 pesos, that is $2.35. And that was our first big problem: what would be the reaction of the public to something very cheap? We decided not to go to something very cheap and to just keep the price at 50% cheaper than the American product. That way it would not be so cheap that the customer would say "What's wrong with this?" And that is how we went to market. You can figure that in a supermarket in Bolivia you will see a big stand in that corner and a little row of MAISOY material. And then on this side you will see corn flakes in 10 different varieties, you will see general foods, you will see a lot of things.

Dr. Harper:

What is the relative profit margin that the grocer receives from selling MAISOY versus Kellogg's corn flakes?

Mr. Bleyer:

Our dealers make 10% of the selling price, and the retailer makes a margin of 20%. On corn flakes and other things he will also make 20%. Even though it is more expensive, he is still making the same profit. One of the conditions affecting sales is that the middle class of my country is attracted to the American product because it is imported, not national. Bolivia is not the only country that has that kind of problem.

Dr. Nichols:

Could I ask what information you might have about what consumers think of MAISOY relative to corn flakes if they didn't know which was which--if you just put it in a bowl in front of them? Do you have any information as to which they would prefer? Which their children would be more likely to consume or to like better if they didn't know it was Kellogg's or MAISOY--just a blind taste test?

Mr. Bleyer:

This kind of taste test we have never done, to tell you the truth. All my friends tell me, "No, my children don't like MAISOY"; or, somebody will tell me, "Yes, they are crazy about MAISOY." The truth is that with the TV publicity, everybody started to buy MAISOY because it was a novelty and they wanted to try that novelty. After four or five months what you are selling is to people who like the product. They are not eating it because it is more nutritious--much more nutritious--than corn flakes. So you have very high sales in the first six months, and then they go right out to a horizontal position. Now we are selling about the same quantity every month. We have not progressed enough in the 1½ years, because we don't have enough publicity to increase the market. But we are selling, and we do have a market.

I would like to ask two questions with respect to the weaning food: (1) is your weaning food supported in suspension? and (2) what income group of the people use your product?

Mr. Bleyer:

The weaning food is not--as you can see--a product that is 100% solid. You must shake the bottle a little to have all the particles in suspension. It is a tiny bottle. Perhaps it would be possible to add something to make it stay in suspension without affecting the things that the children like. It is very important to know that this product has been on the market for only three months. It does not have a long history. But we do know that when you give it in something like a gruel, it works much better because you don't taste the beans so much. This product is designed for the low-income family, because they can spend 25 cents of a dollar for their children's nutrition. They can spend that much, but they will not spend $1.50 for MAISOY flakes.

Prof. Amara:

Is this weaning food for the newborn baby or for what age? The soft drink? And you
didn't give me a clear answer as to whet
they spend their money for MAISOY to fee
children. What percentage of its income
the low-income family spend for this typ
feeding?

Mr. Bleyer:

I want the people who have the lowes
income ($100 for the family--this is nor
the lowest income in our country for lab
to be able to use this product. I think
can start to use the weaning food within
month of birth. I know that this product
has been used by doctors in cases where
ren are allergic to milk.

Dr. Jansen:

We are only going to he able to take
couple more questions.

Ms. Challa:

Mine is not a question, but an observ
I have observed with great interest the n
technology involved in the development of
weaning food LISHA, especially because it
taken into consideration the interest of
Instead of bringing in new technology whi
would have put more work on the already-g
workload of women, I think it is good tha
produce the preparation. I am not very su
that this is going to be low-cost, especi
to vulnerable groups.

Dr. Jansen:

I think that is very much the heart of
whole meeting. The question of reaching t
appropriate and vulnerable groups is going
come up throughout the workshop. One more
question.

Unidentified:

Referring to the drink, from what I ca
see, there is a lot of suspension at the
bottom of the glass. If the children are
drinking this, do they use a spoon later o
or their fingers? This stuff actually is
much like something I saw in India a long
ago. They made it from barley flours and
sugar; the taste and other characteristics
the same. I am wondering whether that is
stuff which was used?

Mr. Bleyer:

I have found that this product is a cop
of something that has been in my country fo
a hundred years and is a kind of custom in
Santa Cruz. It is called a "Santa Cruzena.
We just changed the name of "Cruzena" to
"MAISOY," and this is the reason that in th
months we have sold 100,000 envelopes. It
very easy to sell, something that people ha

known and have been using from the time they were children.

This is not a soft drink just for children; it is for anyone in the street--a lady, a gentleman, anyone. The suspension of the product which you asked about is the same problem when they boil cornmeal and make the same thing. When they offer it to you in the street, they have a big pot and a big wooden spoon, and they serve people in glasses. And it is the same problem. It would be very nice if somebody would teach me how to solve that problem.

Dr. Jansen:

Thank you, Pedro.

Production of Pre-cooked Corn Flours in Small-scale Extruders

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INTRODUCTION

In 1970 ITT showed at the pilot plant level and on an industrial scale that it was technically feasible to substitute wheat semolina in the production of pasta at levels up to 75% using precooked corn flours. (More recent work has proved that pre-cooked rice flour is also a good replacement.) The substituents can be pre-cooked flours for regular pastas or a mixture of the pre-cooked flour (50%) and defatted soy bean flour (25%) for protein-enriched pasta. This pasta contains 18% protein and has a PER of 2.69, while traditional semolina pasta contains 12% protein and has a PER of 0.91 (Casein 2.79) (Buckle et al, 1975). This enriched product has been approved for the Colombian National Food and Nutrition Plan.

The commercial application of the substitution depends on local availability of wheat semolina and relative prices of the pre-cooked flours with respect to the traditional wheat product. The elimination of the wheat subsidy by the local government and present wheat prices are opening the way to the use of pre-cooked flours in industrial production of pasta and creating a demand for pre-cooked cereal flours. The pre-cooking process being applied in Colombia at the moment consists of direct steaming of corn grits in a column followed by flaking in a pair of rollers, drying and grinding of the dried flakes. The process has been designed for corn and up to the moment has not been modified for rice or other cereals. The plants that applied this process usually have a capacity of 10,000 tons of corn per year and require an investment close to U.S. $1.5 million.

Within a government policy of promotion of small-and medium-size food industries and in the presence of a growing demand for pre-cooked cereal flours, it was thought of interest to investigate the possibility of scaling down the pre-cooking process.

For this purpose, the extrusion process was studied, using a Colombian extruder originally designed for the production of corn snacks. Having obtained promising results that indicated the need of building a prototype extruder with a capacity close to 100 kg/hr (IIT 1977), additional trials were run in an extruder built by Meals for Millions Foundation that had the required capacity and some of the features needed in the proposed prototype. The extruder was on loan at KIST (Korean Institute of Science and Technology) at the time the trials were performed and had had some modifications introduced by KIST personnel. 2/ The following sections contain a brief description of the equipment used, some of the technical and economic results obtained in the initial evaluation of the extrusion process and those obtained with the MFM-KIST extruder, as well as recommendations for further work.

RAW MATERIALS

Raw materials used were: (1) corn grits for the snack extruder (0.6% fat, 0.8% fiber); (2) U.S. yellow corn flour (1.3% fat, 0.6% fiber), for the MFM-KIST extruder; (3) regular semolina; and (4) defatted soybean flour for human consumption (50% protein, NSI 50, 100% U.S. mesh 100) for the enriched pasta formula.

DESCRIPTION OF THE EQUIPMENT AND OF OPERATING CONDITIONS

Table I lists the main characteristics of the two extruders used for the study.

The snack extruder (100 kg/hr) is designed to work with corn grits (51% U.S. mesh 22, 10% + U.S. mesh 30). The screw rotates at 600 rpm inside a barrel. At the end of the screw there is an electric resistance that raises the product temperature to 150°C. The extrusion conditions are fixed.

The features that make the MFM-KIST extruder different from the snack extruder are: (1) the heat is produced by friction only; (2) there is the possibility of feeding water into the extruder at a point close to the feed inlet (forced by back air pressure); (3) the inner surfaces of the barrel have four ribs that run parallel to the longitudinal axis of the barrel and (4) it can be operated both with flour and grits.

1/ Dr. Salazar de Buckle was unable to attend the workshop but submitted her paper for inclusion in these Proceedings.

2/ This extruder is built at present by Appropriate Engineering and Manufacturing Co., 815 W. 9th Street, Corona, California, 91720.

Table I. Characteristics of the Two Extruders Under Study

Characteristics	Snack Extruder	Meals for Millions-KIST Extruder
Capacity (kgs/hour)............	100	100
Feeding System.................	Gravity	Activated bin and forced feeding
Screw Configuration............	Constant	Constant
Diameter Screw (inch)..........	2	3
Relation L/D Screw.............	10:1	10:1
Moisture in Corn Product (%)...	14-19*	≈ 35**
Temperature During Extrusion...	150	50-80
Heating or (°C) Cooling Jackets..	No	No
Water Feeding Device............	No	Yes
Source of Heat..................	Mechanical and electrical energy	Mechanical Energy
Motor Power (H.P.).............	30	30
Cost (FOB)......................	U.S. $20,000 1/	U.S. $14,400 2/
(CIF) 1/...................	U.S. $20,000	U.S. $21,600

*Grits. ** Flour or Grits.

1/ Bogotá.
2/ California.

Table II. Quality Specifications for Pre-Cooked Flours to be Used as Wheat Replacements in the Production of Alimentary Pastes.

PRE-COOKED FLOUR (Buckle et al 1975)

CHEMICAL ANALYSIS

Moisture %	12.5 (Max.)
Protein (N x 6.25)	7.0 (Min.)
Crude Fiber %	1.5 (Max.)
Fat %	1.5 (Max.)
Dextrose Index	50 - 70% (Buckle and Pardo, 1973)

PARTICLE SIZE DISTRIBUTION

90% (Min.) Between U.S. ST. mesh 60 and U.S. ST. mesh 150

MICROBIOLOGICAL ANALYSIS

Total Count	10,000 col/g. (Max.)
Coliforms	100 col/g. (Max.)
Fungi	10 col/g. (Max.)
E. Coli	Negative/10 g.

OPERATING CONDITIONS

1. Snack Extruder

Moisture of the grits was the only variable used during the trials (14 to 19%). Temperature at the exit die was kept at 150°C.

2. MFM-KIST Extruder

Extrusion temperature was the variable studied (50, 65, 70, 80°C). The temperature was regulated by adjusting the water feeding rate between 10 and 12 gal/hr. The feeding rate of the flour was kept at 100 kg/hr.

3. Production of Pasta

The pre-cooked products were milled in a laboratory hammer mill to the specified particle size, (Table II), mixed with semolina and defatted soy flour, moisture-conditioned and extruded to form spaghetti in a laboratory Braibanti press, using brass molds without applying vacuum. The pastas were dried under controlled conditions of temperature and relative humidity, similar to those generally applied by industry.

SPECIFICATIONS

1. Pre-cooked corn flour

Table II lists the specifications required for pre-cooked corn flour to be used as a replacement of wheat in pasta making. These specifications have been given by IIT based on the results obtained on laboratory and industrial scales (Buckle et al., 1975). In addition to those listed, the amylograph given by a 10% water suspension of the flour should be similar to No's 1 and 2 of Figure 1. 3/ The viscosity at room temperature should be low, that is, at 90°C, between 500 and 700 BU. These properties facilitate mixing and secure adequate behavior of the dough during the extrusion-forming of the pasta.

2. Protein-Enriched Pastas

The pasta produced with 50% pre-cooked corn flour, 25% semolina and 25% defatted soybean flour should have a texture profile close to the standard semolina pasta (Sandoval, 1977, Bourne et al., 1975). The volume increase should be close to 130 cc/100g and weight increase close to 110 cc/100g after 15 minutes of cooking. Solid losses during cooking should be as low as possible (losses in semolina pasta run between 4-12%).

RESULTS AND DISCUSSION

Figure 1 shows four amylographs: No. 1 corresponds to the regular pre-cooked corn flour commercially available in Colombia. No. 2 is the amylograph of an extruded corn flour produced in a Wenger X-20 extruder (Smith et al., 1978). Both of these flours comply with the specifications (dextrose index, amylography) and could be taken as standards for the discussion of results. No. 3 has a low dextrose index (38) and a low viscosity amylograph, but the curve has a shape similar to No's. 1 and 2. This flour was obtained in the MFM-KIST extruder in the presence of high moisture (+ 35%) and low temperature (80°C). These observations and the results of Table III (that illustrate the influence of extruding temperature on dextrose index and amylography) indicate that it may be possible to obtain a higher dextrose index and a better amylograph in this equipment extruding under lower moisture levels and at higher temperatures. (The conditions could be similar to those used for flour No. 2, Figure 1.) Apparently the extruder can be run under those new conditions, hence no design modifications seem to be required. Amylograph No. 4 is typical of a pre-cooked corn flour produced under low-moisture and high-temperature conditions (snack extruder). It shows 180 BU at low temperatures and a very small viscosity increase during the heating and cooling periods. The dextrose index of this flour is above the specification. The tendency observed in dextrose index and amylographic behavior of the samples run in the snack extruder (Table III) seems to indicate that by lowering the extruding temperature and raising the moisture of the material above 19%, it may be possible to produce pre-cooked flours that will comply with the specifications. Since the snack extruder temperature is fixed, and 19% was the highest moisture content at which the grits could be fed, the present design of this extruder will have to be modified. The data of Table IV illustrate the influence that the characteristics of the pre-cooked flours (DI and amylography) have on the properties of the protein-enriched dough and pasta produced with them. A high dextrose

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3/ "Production of Pre-Cooked Corn Flours for Arepa-Making Using an Extrusion Cooker," O. Smith, T.S. Buckle, A.M.D. Sandoval, G.E. Gonzales. Journal of Food Science, Vol. 44, p. 816, 1979.

Table III. Effect of Extruding Conditions on the Properties of Extrusion-Cooked Corn Floure

Equipment	Sample No.	Moisture during extrusion (%)	Extruding temperature °C	Dextrose Index (a)	Amylography Viscosity B.U. (b)				
					25°C	90°C	90°C (20')	50°C	T_P °C
Snack extruder..	1	14	150	85.5	260	110	105	170	–
	2	16	150	84.6	280	120	105	170	–
	3	18	150	76.8	280	150	135	220	–
	4	19	150	75.4	180	170	170	265	–
MFM-KIST extruder.......	1	100 kg. flour / 40 lt. water	50	18		450	540	1200	81
	2		65-75	23		270	360	740	82
	3		80	38		330	230	900	79

(a) An enzymatic method that measures degree of modification of the starch (Buckle and Pardo, 1972, Smith et al, 1978).
(b) Brabender Viscoamylograph VS-6 Torsion Head 350 Cm-g.
(c) Pasting Temperature.

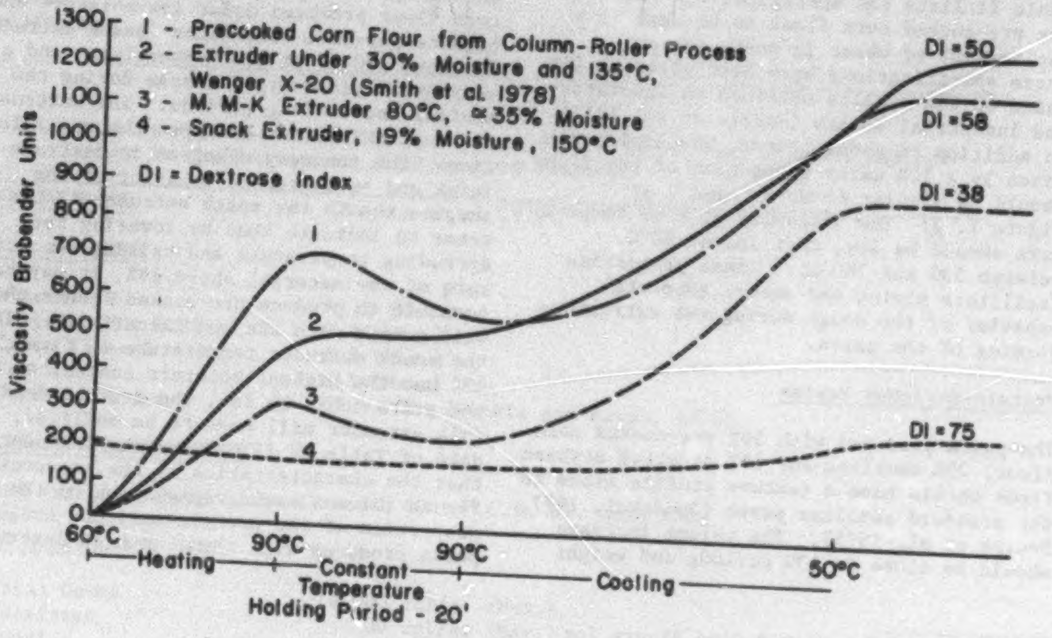

Figure 1. Amylograph viscosity of corn flours produced by the column-roller process and by extrusion cooking.

Table IV. Properties of Protein-Enriched Pastas Produced with Extrusion-Cooked Corn Flours

Equipment	Precooked corn sample (a)	15' Cooking (92^oC) (b)			Observations	
		Vol. Increase: cc/100 g	Wt. Increase: g/100g	Solid Losses %	Dough (c)	Pasta
Snack extruder..	1	145	133	8.0	Lumps formed, difficult to mix, high resistance to extrusion, sticky dough	Wet: Sticky Dry: Good mechanical behavior Cooked: Texture profile close to standard
MFM-Kist Extruder........	1	130	153	11.3	Good mixing	Wet: Spaghetti breaks Dry: Spaghetti breaks
	2	155	164	11.3	Uniform dough	
	3	130	160	14.8	No stickiness	Wet: Non-sticky Dry: Acceptable mechanical behavior

Pasta Formula: 50% pre-cooked flour, 25% semolina, 25% defatted soy flour

(a) See Table III. (b) Buhler method. (c) Behavior during mixing, moisture conditioning and pasta extrusion.

index flour (sample 1, snack extruder) presents mixing problems, the dough is difficult to extrude and stickiness appears in the wet pastas, although the mechanical behavior and texture of the final product are very good. On the other hand, a low dextrose index in the flour (sample 3, MFM-KIST extruder) gives poor mechanical behavior to wet and dry pastas and higher solid losses during cooking. All pastas tested presented acceptable volume and weight increase during cooking.

CONCLUSIONS AND RECOMMENDATIONS

The above results and comments allow us to conclude:

-- It seems feasible to scale down the production of pre-cooked corn flours by using extruders similar to the ones tested in this study.

-- The Meals for Millions-KIST extruder could be used without introducing any design modification. The snack extruder should be provided with adequate feeding devices and temperature control systems. A prototype is needed.

-- The present prices of the two extruders (CIF Bogota) are similar. It is not expected that the modifications proposed for the snack extruder will increase its price significantly; therefore, the two extruders could be technically and economically competitive.

-- The use of locally-produced equipment could present advantages in relation to maintenance and services.

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Summary of the Nutrition Program in Costa Rica

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INTRODUCTION

Since 1973 in Costa Rica there has been interest in establishing a new program in order to reach an important part of the population— that of very low family income— which is left out of most other government programs. The law of Social Development and Family Program was issued in December 1974.

Many programs have been established during these four years (1975-78), and among them the nutrition program is one of major importance. However, this program was organized with a paternalistic pattern, especially in school nutrition centers (CE's). The new government (since May 1978) has been changing these CE's into true instruments of human development and community participation.

PROGRAM'S INCOME

I. A 5% tax on all payrolls of the country unless it is 2,000 colones (about $230) per month or less. The central government, Congress, the Supreme Court of Justice, universities and health institutions do not have to pay this tax. During the year 1979 this income will produce 260 million colones (about 30 million dollars).

II. Thirty-seven-and-a-half percent of what the government gets from sales tax— which is 8% on all sales. This will produce an income in 1979 of nearly 371 million colones (about 43 million U.S. dollars).

III. For 1979 a total income from all sources of 644 million colones (about 74 million dollars).

DISTRIBUTION OF FUNDS

I. Pensions—By law, 20% of total funds must go to pay pensions: 644 x 0.20 = 129 million colones (about 15 million U.S. dollars). These pensions are given to:

A. Persons over 65 with no social security benefits (social security started in Costa Rica in 1943 and at the beginning did not cover everyone).

B. Persons under 65 not able to work (invalids) with no source of support and no social benefits.

C. Abandoned mothers with family obligations unable to work.

D. Special cases of sick people (e.g., Hansen's disease). (A community committee is in charge of assigning these pensions. The committee can cancel a pension or decide on a new one. There is a quota for each community according to its economic and social conditions.)

II. Other activities and participating institutions—The following programs are also financed through 15 different state institutions:

		Millions	
		Colones	U.S. dollars
A.	Nutrition	200.0	23.0
B.	Housing	50.0	5.75
C.	Child Welfare (orphans, abandoned children, nurseries, centers of nutrition)	58.0	6.7
D.	Integral Health Program (10-sub-programs)	80.0	9.2
E.	Organization of Communities	8.5	0.97
F.	Community Production	8.0	0.91
G.	Old-age Welfare	5.0	[illegible]
H.	Potable Water Program	35.0	[illegible]
I.	Land Distribution Problems	50.0	5.75
J.	Technical Workers' Preparation	9.0	1.03
K.	Administration Expenses	10.0	1.4
	Total	513.5	59.0

NUTRITION PROGRAM

A. Participating institutions--Several institutions have shared responsibilities in the nutrition program since January 1975, when it started under the new law (there had been for many years a nutrition program but never so well-financed).

1. Ministry of Public Education--Serving hot meals in most grammar schools of the country: 2,824 schools had the program by October 1978, serving 387,202 children between 6 and 12 years of age; 114 high schools serving 55,000 students between 12 and 18 years of age (see Table I). Total of 442,201 students.

2. Ministry of Health--Serving breakfast and lunch in 540 centers of education and nutrition (CEN). These CEN's attended 40,303 children from one to six years of age, pregnant women and also women in the lactation months (Table II).

   --More than 300 health posts (in very remote and isolated rural communities) have been opened and the program will establish more than 500 before July 1979. These health posts distribute powdered whole milk to each child under six. A total of about 300,000 kg of powdered milk per month is distributed by the Ministry of Health in CEN's, health centers and health posts.

3. National Council of Production (CNP). CNP buys and distributes foods (except vegetables and fruits) to school nutrition centers (CE's) and to CEN's. This state institution, CNP, also distributes the powdered whole milk produced in the country and used in the CE and CEN programs.

4. CARE--CARE imports the raw material for the pea soup manufactured in Costa Rica by PRONUTRE, as well as skim milk, corn/soy blend (CSB), wheat flour, oil, etc. (see Table III). These products are provided by AID and are distributed by the Ministry of Health in CEN's and health posts and by CNP in CE's.

Table I. Cost of 1978 Program School and High School Nutrition Program (CE)

	COSTS (U.S. DOLLARS)				
	Per Year	Per Month	Per Day	Per Child	%
Whole powdered milk	9,860,672.76	821,722.73	31,604.72	0.0715	31.23
Other foods	19,313,883.04	1,609,490.25	60,858.95	0.14	61.17
Employees (cooks)*	2,323,255.81	193,604.65	7,446.33	0.0168	7.35
Transportation**	73,286.23	6,107.19	234.89	0.0005	0.25
TOTAL	31,571,097.84	2,630,924.82	100,144.89	0.2288	100.00

* 1,850 workers with a salary of $104.65 per month.

** Only a few places needtransportation charges; however, cost was distributed among all.

Students in schools and high schools:	442,201
Number of grammar schools:	2,824
Grammar school students:	387,202
Number of high schools:	114
Number of students in high schools:	54,999

Table II. Cost of 1978 Program Centers of Education and Nutrition (CEN)

COSTS - U.S. DOLLARS					
	Annual Cost	Monthly Cost	Daily Cost	Child/Day	%
Milk (whole powdered)	$1,143,823.65	$ 95,318.64	$ 3,660.10	$0.0865	21.00
Non-perishable foods	786,338.73	65,528.23	2,520.52	0.0595	14.46
Fresh foods	2,193,233.02	182,769.42	7,029.59	0.1744	42.34
Cooks	855,627.91	71,302.33	2,742.40	0.0647	15.70
Nutritionists	28,604.65	2,383.72	91.68	0.0022	0.53
Assist. Nutritionist 1	281,023.26	23,418.60	900.72	0.0213	5.15
Assist. Nutritionist 2	28,883.72	2,406.98	92.58	0.0022	0.54
Transportation	15,003.49	1,250.29	48.09	0.0011	0.28
TOTAL	$5,332,538.43	$444,378.21	$17,085.48	$0.4119	100.00

Number of CEN's: 540

Beneficiaries: 40,303 (Children and mothers)

Table III. CARE Foods Distributed in 1978 by Ministry of Health

Food	Quantity	
Peanut Oil	14,171	Kg
Peas	113,078	Kg
Skim milk	80,454	Kg
Soybean oil	74,508	Kg
C.S.M.	2,599	Kg
W.S.B.	84,663	Kg
Wheat flour	67,068	Kg
Pea soup	572,000	Kg

B. Reforms to the 1974 program--Since May 1978, when the newly-elected government took office, a reorganization of the nutrition program has been in process. At the present, these reforms cover only CE's.

C. Reasons for the changes:

1. CE's interfere with the process of teaching because of lack of space, utensils, and other facilities.
2. Program cannot be aimed--as it was--to feed all children regardless of economic and social condition. The new policy is to offer the food to those who need it (biologically or socially).
3. The system of sending the food to schools through the CNP is too paternalistic and does not stimulate local production.
4. Appointment of the cook or kitchen workers by the Ministry of Education is an imposition of central government without community participation.

5. There was a lot of food loss owing to: false delivery (in many cases some of the most expensive foods such as milk, cans of tuna fish, etc., were kept by other cooks, CNP employees or other people who were close to CNP); food spoilage; inadequate preparation and consequent rejection by the children.

D. Changes underway:

1. All CE's were closed during December 1978. Schools end in November and coffee harvesting occurs at this time, so people have good income in these months. All cooks were fired in order to re-open CE's with new personnel (some of the old ones may be reappointed if they were good workers, and if the community so desires).
2. Each CE which is reopened has a committee which receives money from the program. (CNP no longer participates.) With the money they buy the food, pay the cooks and auxiliary personnel, and the government no longer sends food or appoints the workers. The communities are taking over the CE's.
3. Communities will be stimulated to start producing food for the CE's: fresh vegetables, fruits, meat (chicken and rabbit), eggs, etc.
4. Besides money, government also sends a few special foods: skim milk (CARE's skim milk will cover program needs during six months of 1979); pea soup; CSM (corn, soy, milk); CSB (corn-soy blend); and WSB (wheat-soy blend). The reason for sending these foods is that communities have no capacity for producing them locally. In some far-away communities locally-produced fresh milk is used. Naturally, these foods allow a greater variety of menus so that communities have more freedom of choices.
5. Nutritionists, experts on school and community gardens, and agents of human promotion will be visiting and assisting the communities to constantly support and improve the program. Written menus and recipes are recommended.

E. Objectives:

The program aims at four main objectives: nutrition; food sanitation control; local production and use of food; and budget. These four objectives are to be achieved in the CE and in the community as a whole (families) (this is a program of human promotion and not merely a children's feeding program).

1. Nutrition--The members of the committee, the children and all families of the community must know what a balanced meal is. Children are future parents, so besides receiving a balanced meal they must know it is important.
2. Food sanitation control--We must repeat here all that was written down for point 1 above. All health habits related to food must be an important issue.
3. Local production and use of food--This will be fully accomplished with the help of volunteer organizations (e.g., 4S Clubs). Also, the Ministries of Public Education and of Agriculture have a joint program for school and community gardens.
4. Budget--Since CE committees have to handle financial matters (checkbooks, receipts, monthly reports, etc.), they must be carefully instructed as to how to proceed. (There is a manual with all details.) They have to learn how to prepare the budget according to the daily menu and the recipes. All this knowledge should be given not only to members of the committee but also to parents, so that a family budget will be another important issue. At present, people expend money without reason or priorities.

PRONUTRE and the Pea Soup

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LATIN AMERICA

Malnutrition, lack of housing, and poverty are general characteristics of Latin America. Development projects that are currently being carried out in the region have not yet accomplished eradication of extreme poverty.

Almost all the countries have gone through some population increase, with the exceptions of Argentina, Chile and Uruguay, and it is expected that by the end of this century there might be 600 million people, half of them living in main cities.

On the other hand, cities grow unorganized without giving basic services while increasing social, cultural and economical divisions. In the northeast part of Brazil, which they call the "triangle of hunger," 20 million people fight for survival. In Peru a person consumes only approximately 12 grams of animal protein a day. The Mexican level of nutrition is one of the lowest in Latin America. And in all of Latin America, raw materials, transportation, and costs of production have increased in the last few years. Statistics predict no positive change in this difficult situation.

Some experts say that Latin America has the capacity to satisfactorily feed not only the 250 million people, but twice that number and even more. All this, naturally, if Latin America has the proper technology adjusted to the conditions and needs of each country.

In the beginning of 1976 CARE/Costa Rica, with the aid of the Center of Investigation in Food Technology (CITA) got PRONUTRE involved in what was considered by us "proper technology," one that had been unknown to us before that day. A CARE Brady was inctalled in PRONUTRE's plant for experimental purposes. Two days after the startup, PRONUTRE put in an order for its own electric Brady cooker.

PEA SOUP BACKGROUND

During August 1976 the Costa Rican Mission of CARE consulted with CITA about the possibility of using a future donation of dried green peas. After receiving and studying a sample, CITA indicated that the material had good applicability, so the government accepted the offer.

The time between the acceptance of the donation and the remittance of it (November 1976) was short, so CITA proceeded to conduct an urgent preliminary study. For that, they contemplated the availability of other donations such as wheat flour and dry milk, as well as the existence of regular quantities of soybeans that came from an introductory experimental cultivation promoted by CARE-IMAS. Considering the characteristics of the available raw materials and the shortage of time, they concluded that the best choice was to make a dry soup.

PRINCIPAL REASONS FOR THE SELECTION OF A SOUP

The most important reason to use the pea within a formulated product was the local lack of knowledge of its cooking process and the fact that dry soups are generally accepted and used all over the country. Two more important factors that led to the choosing of a soup were: the security of a boiled product that has had a previous cooking stage when making the pea flour; and the fact that the donated product was difficult to use directly like wheat flour. Also, there could have been considerable amounts of the donated product lost through underuse.

Fortunately, there was the possibility of using the total amount of the materials in the preparation of a stable product which goes with the national feeding habit and is easy to use, transport and store and whose usage is easy to control.

AVAILABLE ELEMENTS TO DEVELOP THE FORMULA

1. Raw materials from donations
   a. peas
   b. wheat flour
   c. non-fat dry milk
   d. soybeans
2. Scientific and technical resources
   All those that are available at CITA.

3. Industrial facilities

The "Sociedad Industrial PRONUTRE S. A." had been the base for CITA's experiences in the low-cost extrusion process and offered adequate facilities to make the wanted soup.

NUTRITIONAL-ECONOMIC REFERENCE BASES

1. Cost as a first reference: in terms of calories and proteins, costs of the menus utilized in the national feeding program in 1976 were:

   a. School menu: $0.20/1000 cal and $0.808/100 g protein.

   b. Pre-school menu: $0.1767/1000 cal and $0.9011/100 g protein.

2. Based on the desire to make a real and adequate comparison, a concrete case was sought within the menus of the program. Selected was the black bean and egg soup, prepared for 50 children, with an ingredient cost of $4.9651. This is $0.098/ration, which implies from the cost point of view $.9441/100 cal and $1.643/100 g of protein.

Table No. I shows a comparison with other soups sold on the national market.

The process utilized for the production of the soup is observed in Figure 1.

Tables II and III show the nutritional values along with their cost comparisons. It is important to point out that in both cases in which the soup is produced (with or without costs for raw materials), it is always significantly more economic. On the national market, the pea soup produced a multinational company costs $0.4825/packa of 65 grams, which indicates a cost/kilo of $7.33.

After having carried out acceptability studies, PRONUTRE accepted the challenge of producing, in the time established by the go ernment, 1.8 million kilos of production. A quantity of approximately 1.5 million kilos soup was produced by PRONUTRE during 233 day of production. The Brady worked an average approximately 7.30 hr/day five days/week and gave us an output of 756.16 kilos/hr at a temperature of 285°F and an amperage of 150-175. We experienced 43 electrical fa ures. Rotor maintenance was necessary on 3 occasions. Eight cones with eight bearing rings were required, as were 120 cans of hydra lic oil and 3 filters. Various changes were made on the Brady:

1. The electric system was modified.

2. The base of the motor with the trans mission box was modified.

3. The rotor was modified at the output and at the input.

A total of three men worked in the produc tion department and one man in the cleaning department. Three women were in charge of packing the soup. Production was carried out in 8 hours, while the packing was carried out in 10 hours.

It is important to point out that the Brady at no time gave us mechanical problems.

MODULAR SYSTEM

PRONUTRE has participated in the design o cereal flour plants, and we consider that it i possible to make a compact modular system to be made and sent to any country in a very short

Table I. Picture of Comparisons

Brand	Type	Cost/Kg, Costa Rican colones(₡)	Cost/Kg, $U.S.A.	% Noodle
Lucema	Chicken with thin noodle	27.20	3.1627	27
Malher	Chicken with thin noodle	35.0877	4.9799	70
Continental	Beef with thin noodle	35.4545	4.1226	62.72
Maggi	Beef with thin noodle	44.6153	5.1878	65.38
Pea Soup without costs	Pea concentrate	3.27	.3802	-
Pea soup with costs	Pea concentrate	8.778	1.0206	-

time. In this system, the grains can be introduced to the base mill either by direct transportation or manually. The granulated product falls into a surge tank that will permit an elevator, either screw or bucket, to transport to the Brady on the upper floor. As the product comes out of the Brady, a small air system will cool and separate the hot air from the product, where it will pass through a mill and then to another surge tank. The modular system has only one piece of equipment which could be difficult to make in most of the countries--the Brady cooker.

Table II. Protein & Calories Costs

Pea, Flour, Milk, Soybean   Cost = 0   Cost per ration ₡0.0654
$0.0076 U.S.A.

Kind of Soup	Cost (1000 cal). Costa Rican colones (₡)	$ U.S.A.	Cost (100 gr. of protein) Costa Rican Colones (₡)	$ U.S.A.
Beans & egg soup (Homemade kind)	8.12	0.9441	14.33	1.6662
Commercial soup	8.00	0.9302	16.30	1.8953
Pea soup	1.06	0.1232	1.60	0.1860

Table III. Protein & Calories Costs

With Local Prices of Pea - Flour-milk and soybean   Cost per ration ₡0.1755
$0.02

Kind of Soup	Costs/1000 cal). Costa Rican Colones (₡)	$ U.S.A.	Costs/100 gr. of Protein Costa Rican Colones (₡)	$ U.S.A.
Beans & egg soup	8.12	0.9441	14.33	1.6662
Commercial soup	8.00	0.9302	16.30	1.8953
Pea soup	2.84	0.3302	4.29	.4988

Table IV. Pea Soup

Ingredients:	
Peas	70%
Fortified Flour	7%
Non-fat dry milk	8%
Soybeans	5%
Flavoring	5%
Spices	5%
Moisture	6.94%
Protein	23.35%
Carbohydrate	64.95%
Fat	2.65%
Ash	.91%
Fiber	1.20%

Table V. Nutritional Value of the Pea Soup

Calories/100 gr. of product		Protein/100 gr. of product	
Dried	Dissolved	Dried	Dissolved
308.78	61.75	20.45	4.09

1:10 Solution (20 gr. in 200 c.c.)

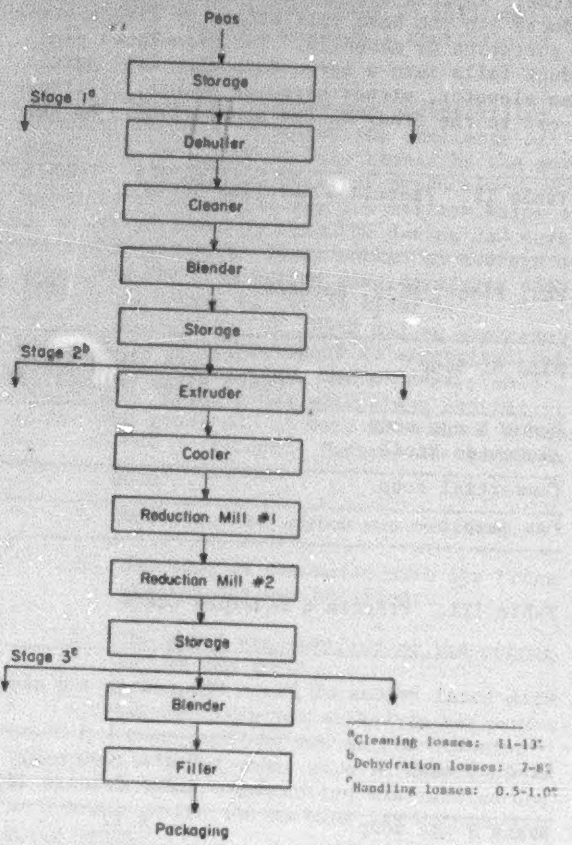
Table VI. MASA-PRONUTRE

Ingredients 100% white corn	
Moisture	8%
Protein	9.93%
Fat	4.15%
Ash	1.42%
Fiber	2.11%

Granulation	
on U.S. #40 wire	0.2%
on U.S. #50 wire	4.0%
on U.S. #60 wire	2.4%
on U.S. #100 wire	24.0%
through U.S. #100 wire	69.0%

Table VII. YOMALE

Soya - Soybean	10%
Harina Arroz - Rice flour	5%
Harina Yuca - Yucca flour	5%
Maize -corn	80%
Temp.	325°F


Peas
Storage
Stage 1[a]
Dehuller
Cleaner
Blender
Storage
Stage 2[b]
Extruder
Cooler
Reduction Mill #1
Reduction Mill #2
Storage
Stage 3[c]
Blender
Filler
Packaging

[a] Cleaning losses: 11-13

[b] Dehydration losses: 7-8

[c] Handling losses: 0.5-1.0

Figure 1. Pea soup processing system stages.

Table VIII. NUTRITIONAL COMPARISON

All weights are 6 oz.

	Nestum $2.32	Gerber $2.09	Corn Flakes .8113	Yomale .1744
Protein	30%	35	7.9	10.32
Calories	375	390	386	370.65
Fat	1.5%	6.1	0.4	4.16
Calcium	600	640	17	33.30
Phosphorous	700	500	45	196.90
Iron	2	10	1.4	2.514

The LEC System in Costa Rica

Justin R. Jackson
CARE-Costa Rica

A recent newsletter of the League for International Food Education (LIFE) stated that nutrition planners at a conference held in Rio de Janeiro criticized nutrition intervention feeding programs on the basis that traditionally these programs are expensive and are nonsupportive of food production. Hence they claimed the programs are actually detrimental to a host country's poor farmers, making the country perpetually dependent on richer food-producing countries. On the other hand, the report also stated that the advantages of such intervention programs are that they are easily controlled, their effects predictable, they are popular with both the recipients and political decision-makers, and are probably the only way for developing countries to quickly reach persons having severe nutrient deficiencies.

In Costa Rica, the Government of Costa Rica, CARE and USAID have addressed the two mentioned problems to reduce their adverse effects while taking advantage of the traditional positive aspects of nutrition intervention feeding programs. In 1976, the three parties signed a three-year agreement which provided for collaboration in undertaking a food production program which places emphasis on soybean cultivation and the construction of a food processing plant to produce low-cost nutritious food products for Costa Rica's nutrition feeding programs. With this vertically integrated program, it is hoped that the nutrition programs will stimulate local production of grains, particularly soybean and corn, as the processing plant will provide a ready market for the produce. The LEC plant will process the produce at a low cost, thus reducing the cost to the government for undertaking the nutrition intervention programs.

The low-cost extrusion cooking plant constructed under the project is now ready for commissioning, with its inauguration scheduled for late February.

The plant is unique. It differs from other similar plants so far constructed like those in Tanzania and Sri Lanka, for example, in that it contains cleaning and dehulling equipment. Also, not only will extrusion cooking be used to produce CSB and CSM, but also two alternative systems are available for full-fat soy flour (FFSF) processing, namely, extrusion or roasting. The plant therefore offers the opportunity to utilize these two alternative processes and to compare the products and costs (Figures 1 and 2).

The extrusion capacity of the plant is presently 455 Kg. (1,000 lbs.) an hour for an estimated annual production capacity of 2,275 M.T. (five million lbs.) per year. It is estimated that the extrusion capacity can be doubled by the addition of a second Brady together with minor equipment alterations, at a cost of less than $30,000. The roaster has an estimated capacity of 910 Kg. (2,000 lbs.) per hour for an annual capacity of 4,550 M.T. (ten million lbs.).

The cost of the equipment for the plant and its installation is just under $145,000; the building has cost $107,000. Thus the depreciable capital cost per kilo is less than US$0.002 (US$0.001/lb.) based on equipment depreciated in five years and building in twenty, depreciated at full production capacity. Even when depreciating the plant and equipment at the much lower first year target production rate of 1,180 M.T. (2.6 million lbs.), the capital depreciation comes to only US$0.029/Kg. (US$0.013/lb.) -- remarkably low cost.

CARE and USAID have shared the cost of the building and equipment. The Government of Costa Rica will be covering all costs associated with the processing of the nutritious food products.

The processing system constructed in Costa Rica has been designed by Colorado State University (CSU) so that raw materials are received regularly every two or three days.

Raw materials enter a receiving area where they are off-loaded. Gunny bags containing the grain are dumped into a receiving hopper whence they are conveyed by screw conveyor to a clipper. The function of the clipper is to clean the grain of all foreign matter, except that which is the same size of the grain being cleaned. A blower carries away light-weight matter, while a series of screens separate any foreign matter either larger or smaller than the grain. From the clipper the grain is carried by

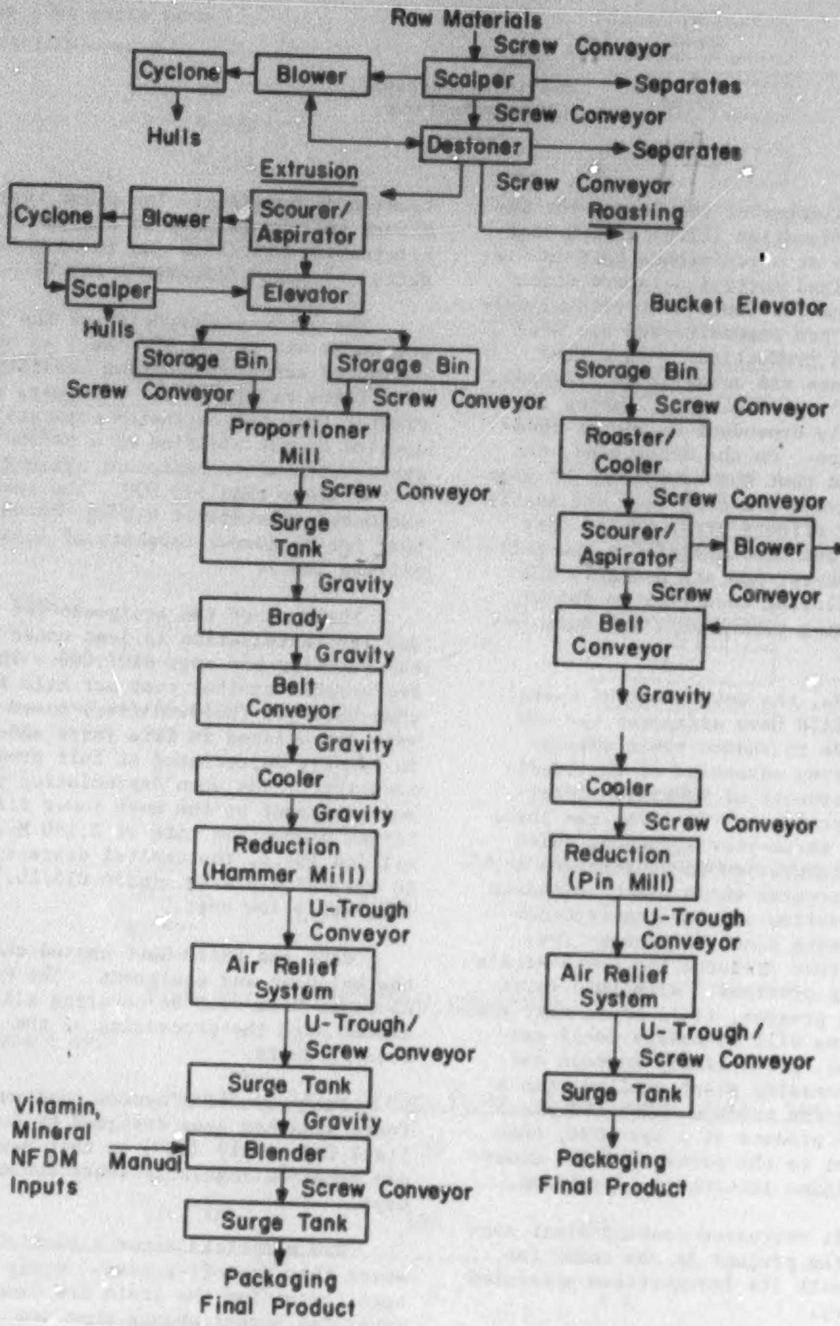

Raw Materials
Screw Conveyor
Cyclone
Blower
Scalper
Separates
Hulls
Screw Conveyor
Destoner
Separates
Extrusion
Screw Conveyor
Roasting
Cyclone
Blower
Scourer/ Aspirator
Scalper
Elevator
Hulls
Bucket Elevator
Storage Bin
Storage Bin
Storage Bin
Screw Conveyor
Screw Conveyor
Screw Conveyor
Proportioner Mill
Roaster/ Cooler
Screw Conveyor
Screw Conveyor
Surge Tank
Scourer/ Aspirator
Blower
Cyclone
Gravity
Screw Conveyor
Brady
Belt Conveyor
Scalper
Gravity
Belt Conveyor
Hulls
Gravity
Gravity
Cooler
Cooler
Gravity
Screw Conveyor
Reduction (Hammer Mill)
Reduction (Pin Mill)
U-Trough Conveyor
U-Trough Conveyor
Air Relief System
Air Relief System
U-Trough/ Screw Conveyor
U-Trough/ Screw Conveyor
Surge Tank
Surge Tank
Vitamin, Mineral NFDM Inputs
Gravity
Manual
Blender
Packaging Final Product
Screw Conveyor
Surge Tank
Packaging Final Product

Figure 1. Block diagram of CARE/Costa Rica processing systems.

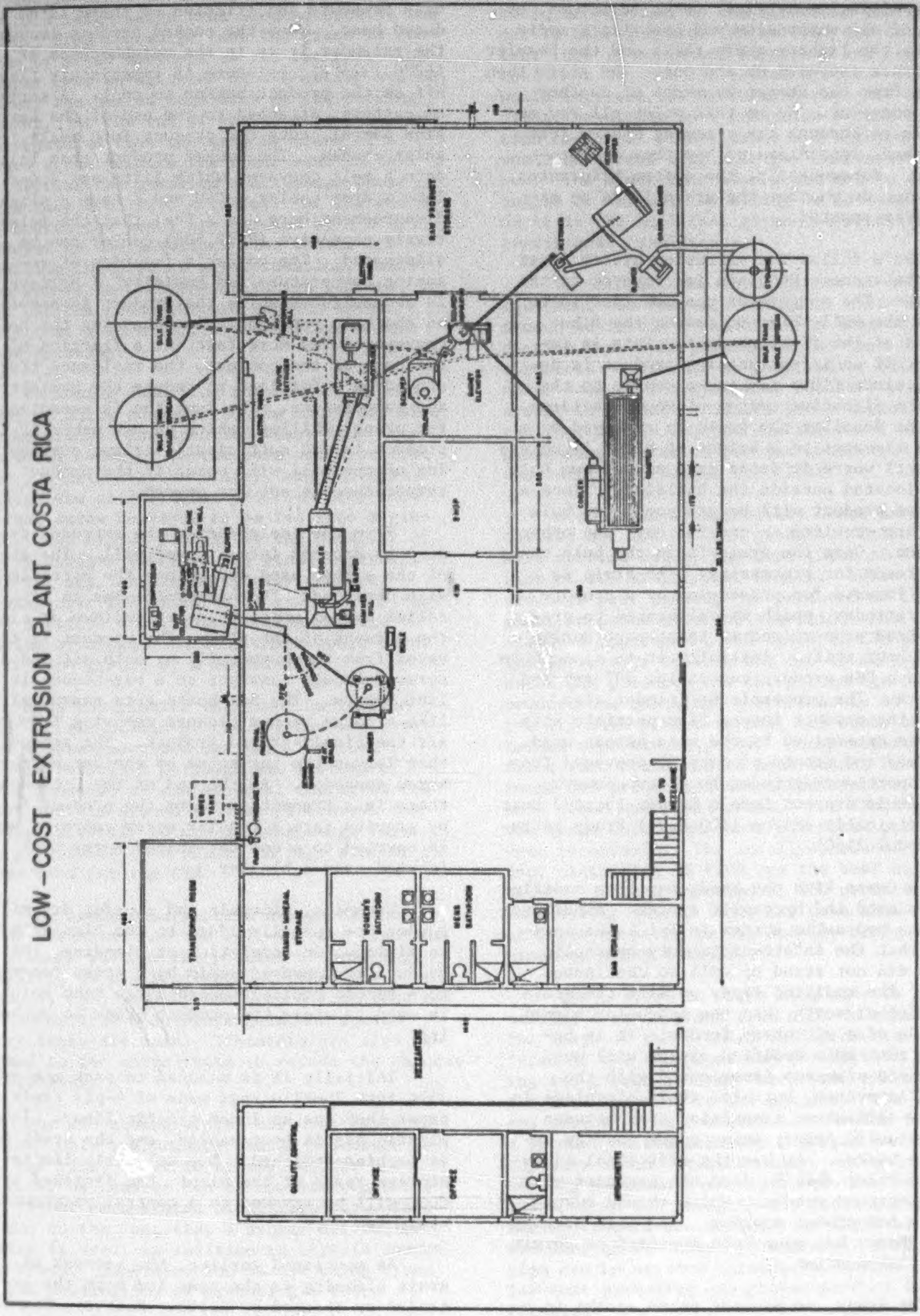

LOW-COST EXTRUSION PLANT COSTA RICA
TRANSFORMER ROOM
WOMEN'S BATHROOM
MEN'S BATHROOM
MEZZANINE
QUALITY CONTROL
OFFICE
OFFICE
SHOP
COOLER
RAW PRODUCT STORAGE

Figure 2. Costa Rica plant layout.

screw conveyor to a stoner, which separates the remaining impurities, rocks or stones, by means of air suspension and specific gravity whereby the lighter grain falls and the heavier stones are conveyed up and out. The grain then passes from the stoner by means of another screw conveyor. Up to this point all raw materials go through the cleaning system just described, regardless of how they are processed. Subsequently, the system bifurcates, depending on whether the grain is to be extruded or roasted.

Let's follow the extrusion system first. From the stoner the grain is conveyed to the dehuller. The purpose of the dehuller is to remove the hull so as to reduce the fiber content of the final product. This is important if an infant weaning product is desired, since fiber may cause damage to the delicate digestive system of young children. From the dehuller the grain is conveyed by a bucket elevator to a height of about 17 meters (55 feet) where it drops into one of two bulk tanks located outside the building. Since a CSB-type product will be produced, two bulk tanks are required -- one for soy, the other for corn. Once the grain is in the bulk tanks it is ready for processing. The grain is called forward for processing by a proportioner/grinder, which is calibrated to predetermined proportions at least once during each 8-hour shift. Initially it is planned to produce a CSB product containing 30% soy and 70% corn. The proportioner/grinder also grinds the product into a fine particle size which is determined by the size screen used. The mixed and ground product is conveyed from the proportioner/grinder by screw conveyor where it is dropped into a hopper located over an electrically-driven (100 H.P.) Brady Extruder (Model 2160).

In Costa Rica the Brady has been modified to eliminate the hydraulic system. Experience with the hydraulic system in Sri Lanka indicated that the intermediate-duty hydraulic system did not stand up well to continuous usage. The modified Brady permits the grain to be fed directly into the extrusion barrel by means of a vibratory feeder. It is believed that this modified system will not only avoid problems experienced with the hydraulic system, but also avoid pluggings in the now-eliminated transition area between the hydraulic driver screw auger and the extrusion barrel. It has the additional advantage of being able to feed the extruder with a finer-ground product, which should result in more homogenous cooking. The main bearing of the Brady has also been modified to permit better lubrication.

The Brady, as you are aware, cooks in a continuous fashion through a combination of high pressure and friction -- there is no induced heat. When the cooked product leaves the extruder it is in the neighborhood of 162°C (325°F); moisture is immediately flashe off as the product begins to cool. A series of cutters, attached to the end of the extrusion barrel, cuts the product into small irregular chunks. The cooked product than falls onto a belt conveyor which lifts and drops it into a drum cooler. CSU and I have a slight disagreement here, as I feel that the relatively expensive (US$7,500) cooler can be eliminated. The cooler's function of reducing temperature and humidity, I believe, is accomplished while the product is conveyed on the belt conveyor. By extending the belt conveyor a few more feet (at a fraction of the cost of the cooler), the residence time should be sufficient to reduce the humidity and temperature. The function is essential for proper milling, which cannot occur if the product is not sufficiently crisp; overheating of the mill will occur if the product temperature is not low enough.

From the cooler/drier the extruded product is dropped into a hammermill. The size of the screen used determines the particle size obtained. The hammermill has an air relief system which helps to relieve or clean the screens of the mill. The product is conveyed from the hammermill by both air and a screw U-trough conveyor to a bag-house air relief system. The bag-house acts essentially like a large vacuum cleaner removing from the air the finely-ground product. The product then leaves the bag-house by another U-trough screw conveyor. At the end of the U-trough there is a transition where the product falls by gravity into a regular screw conveyor and is carried to a conical-shaped surge tank located over a blender.

Vitamins, minerals and non-fat dry milk powder are manually added to the blender prior to mixing. On completion of blending, the product is conveyed again by a screw conveyor to a second conical-shaped surge tank which is used to store the product prior to packaging.

Initially it is planned to pack the product into [illegible]-kilo bags made of 4-ply Kraft paper that has an inner plastic liner. The plastic bag is heat-sealed, and the Kraft bag is machine-stitched. Due to fairly limited storage space at the plant, the finished product will be removed to a central warehouse every two days.

As mentioned earlier, the process of grain cleaning is the same for both the extruded or roasted products. However, for the roasted product, the grain bypasses the dehuller and is conveyed through the bucket elevator to a large surge tank located outside the plant. From the surge tank the grain is conveyed by screw conveyor to the roaster. The roaster uses an agitated sand roasting system, whereby the heated sand acts as the cooking element. At the end of the roaster the beans are separated from the sand by means of a screen which permits the finer sand to fall but carries the beans to a discharge shoot where they drop into a cooler. At the end of the cooker the beans are carried by a screw conveyer to the dehuller. The reason for dehulling the product after roasting, rather than before as with the extrusion process, is that CSU has found through various experiments that a more complete dehulling occurs after roasting.

Following dehulling the product is conveyed by screw conveyor to the extrusion side of the plant. The dehulled beans drop from the screw conveyor to the belt conveyor (the same one used for the Brady), are conveyed through the cooler/drier and then drop into another screw conveyor to be fed into a pinmill. The Alpine pinmill is the Cadillac of our Volkswagen system. The pinmill permits full-fat soy, an extremely oily product (having over 20% oil), to be ground to a very fine particle size, thus eliminating the problem of clogged screens which would occur if it were ground by a hammermill.

From the pinmill the flour is removed from the air stream by the bag-house air relief system described earlier. It then travels through a U-trough but instead of being conveyed to the blender, the screw conveyor swivels around so that it conveys the product directly to the packing surge tank. The product is then packed in bags similar to those used for the CSM.

The conical surge tank design has been found essential for the full-fat soy flour as it greatly reduces the problem of bridging. Bridging, or the hindrance of free-flow of the product, is caused by the high oil content and is encountered when rectangular or square surge tanks are used. Vibrators are also attached to the surge tanks to reduce the chances of bridging.

The processing system has been designed so that only one product can be processed at any one time. That is to say, either the extruder or roaster can be operated, but the two cannot be operated simultaneously. This is due to the fact that a single air relief system is used, in addition to certain common conveyors. Consideration is now being given to the possibility of producing a third product -- a black bean soup -- using the roaster. It is possible that this product could be produced at the same time the extruder is making either CSB or FFSF due to the fact that it would not be milled and thus would not use the air relief system. This would increase the production capacity of the plant, resulting in a reduction of the production costs per pound, since all fixed costs would be spread over a larger production output. The black bean soup would not be dehulled or milled. Dehulling is not required, as it is the hull that gives the product its traditional consistency.

In October, the installation of the equipment was complete enough so that it was deemed advisable to undertake a limited production run. The purpose of the test run was threefold: to provide an opportunity for a shake-down of the system to identify problem areas; to produce products for acceptability testing; and to demonstrate the plant and processing system to parties interested in contracting to manage the plant.

Subsequent acceptability tests have been carried out for the CSM product. These tests were carried out by the Department of Nutrition of the Ministry of Health. Three CSM products were tested, two produced at the LEC plant in Costa Rica and the third, the standard imported PL 480 Title II CSM product. The difference between the two locally-produced CSM products was the percentage of milk powder: one contained approximately 8% nonfat dry milk powder (NFDM); the other contained approximately 15%. Acceptability tests were conducted in both school lunchrooms and pre-school nutrition centers in both urban and rural areas. The findings of the tests determined that all three products were acceptable: the locally-produced product containing 8% NFDM had the best acceptability; and the imported PL 480 product came in a strong third. This may have been due, at least in part, to the locally-produced products' being fresher.

The project in Costa Rica also is receiving a small grant from USDA to enhance the image of the blended food products produced at the LEC plant and to identify packaging and a product name which will enhance consumer reaction to the product. The lesson learned from commercial marketing is that a product be attractively packaged and acceptably named. Traditionally, nutrition feeding programs have neglected consumer image, often resulting in the feeling that these products are inferior or intended for the poor or for those on welfare. This situation can be avoided through attractive but low-cost packaging and proper product identification.

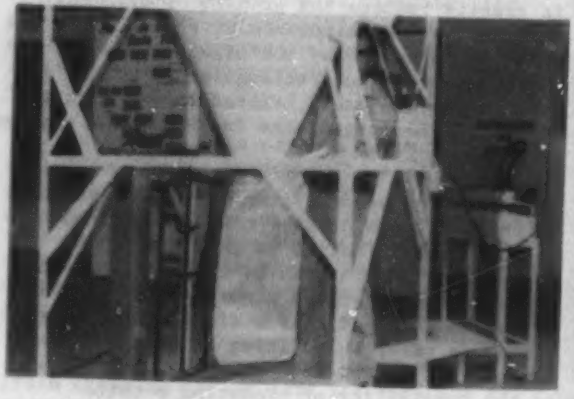
Now that the processing plant is nearly completed, CARE and the Ministry of Health have been actively seeking a competent food processing company to manage and operate the plant. In October, at the time of the limited production run, 28 food processing companies were invited to observe a demonstration of the equipment. Nineteen of the 28 companies responded to the invitation, indicating interest; eleven actually attended. Subsequently, the 19 interested companies were invited to prequalify for the management and operation of the plant by submission of a prequalification document. The purpose of this document was to provide the selection committee with criteria for judging the qualifications of interested companies. Four companies submitted their prequalification documents during December. These documents were reviewed during the earlier part of January. With the assistance of Mr. Alden Ackels, a consultant hired by USDA, a meeting was held with the four prequalified companies to give them a better understanding of what exactly would be required in terms of the plant's operations and management and to explain the bidding procedures; and to provide them with a copy of the draft contract. The prequalified companies have been given a deadline of 15 February for submission of their bids. The selection of the party to operate and manage the plant will be on the basis of:

1. Price
2. Responsiveness to the draft contract
3. The qualifications of the bidders.

Having been involved with the planning, design, construction and operation of three plants, two in Sri Lanka and one in Costa Rica, I would like to make some comments which hopefully will benefit those contemplating the implementation of this type of low-cost extrusion cooking program. Of first importance, in my opinion, is the need to conduct adequate feasibility studies. Such a study should be conducted to determine the optimum location for the plant. For the site selection, consideration should be given to the area from which the raw materials will be received, and equally important is the area where the finished products will be distributed or consumed. Consideration should be given to the means of transport for both incoming and outgoing materials, be it by road, rail or both. The study should include an assessment of the availability and dependability of the electric power supply, even when a diesel-operated extruder is to be utilized. The availability of a labor force and its capacity to operate an LEC plant is also important. Spare parts availability within the country and repair facilities close to the site selected are also important considerations.

Once a site has been selected, careful consideration should be given to the design of the building. This is not something that should be taken lightly. To a large degree, the success of the program will not only depend on how well the design is made for the processing system, but also how well the building itself has been designed in terms of functional efficiency. Some essential items are pest control for rodent, bird and insect infestation, building sanitation and maintenance. The location of employees' facilities and toilets must be carefully considered for sanitation reasons. Even details regarding the quality and type of floors or windows for ventilation and light are details which must receive adequate attention and care. And a very important element is consideration as to the type and quantity of storage for raw and finished products and their handling. In my opinion, a professional food systems engineer should undertake this important work. I also suggest consideration be given to a vertical rather than horizontal system. Vertical systems are normally used for most large-scale mills.

Finally, I am reminded that while donors such as CARE, other volunteer agencies and USAID provide initial funding for many of these projects, it is critical that we not forget that the plant and system (that are designed and constructed) require the active participation of our host countries. Their contribution to the project in financial terms once the project becomes operational frequently far exceeds the donor input even during the first year of operation. They must be given an opportunity to participate as full partners at all stages. We also have an obligation to insure that the systems, building facilities and equipment provided are of the most efficient available in terms of the objectives of the low-cost extrusion cooking program, keeping in mind the objective of providing an appetizing and high-quality nutritious product at low cost.



Plant worker packaging Nutri Soy.

LEC Food Development and Utilization in Tanzania

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INTRODUCTION

Application of a LEC system for food production in Tanzania is a result of many attempts at selection of process systems that could effectively process available agricultural products--either alone or in blends--to produce foods of nutritious substance and low enough in cost to suit the economic strata of the population. The exercise was necessitated by the high prevalence of malnutrition in the country, particularly among the vulnerable groups consisting of lactating mothers and pregnant women, infants and school-age children. Malnutrition in Tanzania has been linked to various socioeconomic causes, and these have since been analyzed (Mohamed and McKeag, 1970; Maletnlema 1970, 1975). Dependency of much of the population on cereals and starch-based foods--however inadequate nutritionally--has very much favored the perpetuation of this malady. Tanzania's main diets are chiefly drawn from corn, sorghum, rice, cassava and plantain. Although sufficiently produced (Table I), full utilization of legumes has always been on the sidelines. Fortification of cereal with protein-rich legumes and oil seeds has been considered, but process methods attempted have proved inadequate to produce foods of aesthetic quality at low enough cost to meet the needs of the intended group.

BACKGROUND

Mohamed and McKeag (1970) in a review of nutrition activities in Tanzania reported that the enrichment of sembe (60% extracted maize flour) and fortification of other local staples with protein-rich sources such as dry meat powder, groundnut flour and soyflour was strongly advocated in the early sixties. Local research indicated that mixtures of maize or sorghum flour containing up to 25% soy flour were acceptable. Local bean flour was accepted up to 15% (Mosha, 1976). Following this background, some proposals were made (Maletnlema, 1975) to:

a) Upgrade sembe through dual processing of sembe and beans through hammer mills.

Table I. Harvested Food Products (Tons) 76/77

Maize	1,673,000
Sorghum	519,000
Paddy	314,000
Millet	236,000
Wheat	64,000
Cassava	817,000
Sweet Potatoes	821,000
Irish Potato	78,000
Bananas & Plantains	1,943,000
Mixed Beans	255,000
Peas and Pulses	82,000
Groundnuts	34,000
Sesame	16,200
Sunflour	5,900
Soybeans	900

Source; TFNC Data Report on the Food and Nutrition Situation in Tanzania 1972/73 - 1976/77. TFNC, March 1978.

b) Manufacture high-protein baby foods such as full-fat soy flour, fish protein concentrate (FPC), beef flour (especially game meat), dry skim milk (DSM) and high-protein biscuits.

These proposals were rejected owing to their excessive costs and lack of adequate raw materials.

In other developments, the United Nations Food and Agricultural Organization carried out high-protein weaning foods processing feasibility studies (Her, 1975). Formulations included a blend of maize flour, soya, local beans, milk powder and vitamin and mineral mixes processed into biscuits after pretreatment with alpha-amylase. Acceptability studies of the biscuits conducted on several schoolchildren and some selected adults showed that the product was not of good aesthetic quality (Kahuranange, 1976). Besides, the process employed was rather intricate to produce consistent products.

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[1] This paper was presented by Mr. Lukoo.

Other efforts in the development of highly nutritious foods in Tanzania included the establishment of a village-level soy processing project where villagers used hand-operated equipment to process soybeans into full-fat soy flour, soy milk and curd. The products were incorporated into local cereal staples. The results were encouraging, but given the high labor input into the project, its viability is in question (Mosha, 1976).

LEC FOOD PRODUCT DEVELOPMENT

Various blends of maize/soybeans were processed through a Brady crop cooker in Nairobi in 1976. Blends of 70/30 and 80/20 maize/soybeans were shipped to Tanzania for acceptability studies and other development studies. Results of acceptability studies conducted on schoolchildren and some selected adults showed that the products were fairly acceptable (Lukoo, 1976). Given the low cost of the system (Stone, 1976), steps were taken to acquire the system in Tanzania to produce adequate quantities to replace PL 480 Title II donated foods and to conduct market promotion studies for future large-scale commercial production of the products.

A Brady crop cooker production system was installed at the National Milling Corporation in May 1978, and a steady production program has been going on since. The products have been distributed to MCH clinics for assessment of the impact of the products as suitable replacements for PL 480 Title II donated foods.

MAJOR ACTIVITIES

The Tanzanian government realizes the importance of Maternal Child Health (MCH) services. These services are coordinated by the MCH section in the Division of Preventive Medicine in the Ministry of Health. There are 1236 MCH clinics (Kimati, 1977, Mzingi, 1978) in the country covering an average radius of about ten kilometers. This coupled with the villagization program implies over 50% coverage of the target population.

The clinics offer basic services daily at hospitals and dispensaries all over the country. These are prenatal and antenatal treatment to mothers, inoculations to children, family planning, anti-malaria tablets and distribution of food aid items, especially a corn/soy/milk blended food, powdered milk, cooking oil, rolled oats and bulgur wheat. In 1975/76, USAID supplied 5,540 tons of corn/soy/milk blend, and it provided 3,180 tons in 1976/77 under Title II grants (Anon, 1977). Most of this high-protein supplement was distributed through the MCH system and Catholic Relief Services, but it is doubtful whether it reached the targeted groups intact. This background necessitated the installation of the Brady at National Milling to replace, at least in part, some of the Title II corn/soy/milk blend.

THE PRODUCT

Details of the production of corn/soy/milk blends are covered by Kopakopa (1976). Since the Brady started production last May, to date 500 tons have been produced. The Ministry of Health MCH Unit has been very actively involved in distributing the product. Usually, supplementary foods are given to malnourished children attending the clinics. The amount of product available was initially limited, so it was decided to concentrate in the city of Dar es Salaam in six clinics, five clinics in the Coast Region and currently all districts in the Tanga region. The areas mentioned are all within easy reach of Dar es Salaam and have on average 20% malnutrition among children under five years of age. It is hoped to move on to the next adjacent regions, namely Morogoro and Dodoma. Later, if production is enough, all MCH centers will be provided.

PACKAGING

The product has been brand-named "LISHA." It will continue being distributed through institutional and--later--commercial channels. It is currently packed in 2-kg. polythene bags, and ten of these bags are contained in a multi-walled paper carton.

Efforts are being made in conjunction with packaging firms to develop a suitable package for the commercial product with the objective of competing effectively against imported formulae.

The primary package (enclosing product content) will be a polythene bag. The secondary package, enclosing the primary package, will be a rectangular cardboard box. This package will offer additional protection and will carry all the necessary information as required by law. It will also facilitate display of the product in retail shops. The possibility of protecting the labelling and artwork on the secondary package by putting over it a thin plastic film is also being explored. The shipping package will be made up of thick-walled cardboard cartons and will enclose a number of secondary packages.

During test marketing of the product, 1-kg. and 0.5-kg. packages will be used. These sizes are considered convenient to most prospective buyers in terms of cost.

CONSUMER RESPONSE

While work on the development of the package is going on, consumer responses towards the product is being compiled. Respondents are mothers attending MCH clinics who, in the course of doing so, have been issued LISHA. Response data are collected by MCH personnel and returned to TFNC for analysis and compilation.

POTENTIAL IMPORT SUBSTITUTION

Tanzania has been importing fairly large quantities of cereal-based weaning foods mainly as food aid. Only 220 tons were imported for commercial purposes, although the amount to be distributed through normal retail outlets will rise to 320 tons by 1980 (TISCO, 1978). CRS/MCH projections for the same year show that they may require over 8,000 tons of donated foods for their clinics. With a low-priced product, the demand for the marketed product could be expected to be higher than that estimated by TISCO. On the other hand, MCH/CRS estimates are only indicative, in the sense that they are not based on the actual requirements of children suffering from malnutrition, since accurate estimates of malnourished recipients have not been worked out.

PRICING

Before production started it was estimated that the retail price of LISHA would be around T.Sh. 5/-. [1] However, TFNC currently estimates production costs of T.Sh. 7/- [2] per kg. Market retail price will be worked out soon based on detailed production costs, distributors' handling costs and consumer purchasing power.

COMMERCIAL DISTRIBUTION

Commercialization of the product will be in two phases. In the first phase efforts will be made to promote the product through sales promotion firms. The second phase will involve limited distribution of the product to commercial centers, particularly regional trading companies.

FUTURE PROSPECTS

INCREASED LISHA PRODUCTION

It is encouraging to note that despite logistical problems--especially procurement of vitamin/mineral mixes and essential spare parts--the extrusion cooker has performed fairly well. The per-kilogram retail price of LISHA is much lower than the average price of Shs. 30.00 [3] per kilo of imported cereal-based weaning food products (Mlingi, 1978). In view of the above-mentioned, it is indicative that the product has a chance to compete with imported similar products on a commercial basis, especially if it is officially protected against unfair competition by import restrictions. Even if the commercial approach falters, the MCH clinics, which are being strengthened and increased in number to reach most of the population, will require over 3,500 tons annually if we are to replace the Title II food alone.

FORMULATION OF RELATED PRODUCTS USING THE LEC SYSTEM

The market in the country for such foods as high-protein food supplements has not been explored. There is room for the fabrication of low-cost snacks using other local cereals, such as sorghum and millet, root crops, such as cassava, and high-protein sources, such as cottonseed, simsim and other oil seeds, which are easily available locally.

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[1] U.S. $0.675

[2] U.S. $0.946

[3] U.S. $4.05.

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The National Milling Corporation LEC Plant and the Production of LISHA

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INTRODUCTION

The inception of the LEC system in Tanzania has been conceived as a result of a joint technical program between USAID and the National Milling Corporation, with assistance and coordination from other related institutions like the Tanzania Food and Nutrition Center and Colorado State University.

The objective of the project is geared towards being able to utilize locally-produced cereals and legumes for the processing of low-cost high-protein foods which have hitherto been imported. As such, it is a step in line with national objectives of directing efforts towards self-sufficiency.

The project was partly funded by AID, with technical assistance from Colorado State University, and installation was carried out by NMC. The installation phase was started in 1977. The plant installation was completed, test runs were carried out, and the plant is now producing a finished product called LISHA. 2/ The overall costs of the equipment purchased for the plant approximated T. Shs. 400,000.00. 3/ The floor area, including offices, is 36.5m x 11m.

THE LEC PRODUCTION FACILITY

The National Milling Corporation LEC system consists of the following equipment:

Cracking mill - Davis Model 10 x 10
Gravity table with aspirating feeder - Oliver Model 50
Bucket elevator - Universal Model C2
Bulk tanks- Read Model BF 10 & BS 18
Proportional mill - Modern Mill Model 400
Extruder - Brady Model 2160
Water application system - Fisher Porter/ Hoke Watts
Belt conveyor - Versa Ferguson Model 600-R
Cooler - Dorsey McComb Cooler
Final grinder with Air Relief System - Prater 6HGSI
Paddle blender - Marion Model 2030
Blender scale - Cardinal FS-2F Model 34173
Electrical distribution control equipment - square D Miscellaneous
Packaging scales (2) Accu - Weight Model M-410
Heat sealers (2) - Allied Automation - Sergeant 312
Surge tank
Volumetric Packager
Screw Conveyors (6)
Exhaust fans (2)
Laboratory equipment

Figure 1 gives the flow diagram of the plant at NMC. The arrangement of the equipment falls under three sections, which are:

1. Pre-processing section, where soyabeans are dehulled and then with dehulled, degermed maize grits are filled in bulk tanks using the bucket elevator.

2. Processing section, where initial mixing of corn and soyabeans is done using a proportional mill and then extruded. The extruded product is cooled down through the open belt conveyor and cooler drum and finally ground, using the Prater Mill. The last part of processing section is comprised of the paddle blender, where vitamin and mineral premixes and NFDM are added.

3. Packaging line section, where the final product is weighed and sealed in polybags and then packed in paper bags, each containing 20 kgs of product. The overall operation of the essential equipment has been briefly outlined in the first LEC International Workshop Proceedings (Tribelhorn, 1976).

PRODUCTION OF LISHA

LISHA (corn-soy-milk) is produced by using corn, soyabeans and milk fortified with vitamins and minerals. Major ingredients--corn, soyabeans and milk (NFDM)--are mixed at approximately 70%, 25% and 5%, respectively. Minerals and vitamins are then added at 2.7% and 0.1% rates, respectively.

The production process starts with whole soyabeans which are filled into a cracking mill (roller-type) in which the hulls are loosened. Beans with loosened hulls are

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1/ Mr. Kepakepa is employed by the Tanzania Food and Nutrition Center and is on assignment to the National Milling Corporation.
2/ LISHA: Swahili word meaning "to feed."
3/ T. Shs. 7.40 = U. S. $1.00 (January 1979).

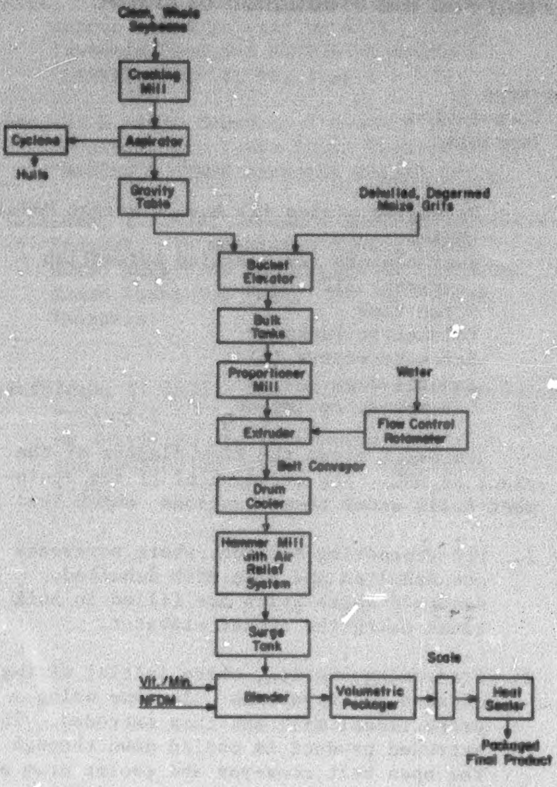

Clean, Whole Soybeans
Cracking Mill
Cyclone
Hulls
Aspirator
Gravity Table
Dehulled, Degermed Maize Grits
Bucket Elevator
Bulk Tanks
Proportioner Mill
Water
Flow Control Rotameter
Extruder
Belt Conveyor
Drum Cooler
Hammer Mill with Air Relief System
Surge Tank
Scale
Vit./Min.
NFDM
Blender
Volumetric Packager
Heat Sealer
Packaged Final Product

Figure 1. Flow diagram of weaning food plant, Dar es Salaam.

conveyed through an inclined screw conveyor to the aspirator and gravity table for separating the hulls. Dehulled soyabeans enter the input hopper of the bucket elevator, which lifts the beans and pours them into a bulk storage tank. The system of filling the other bulk storage tank with maize is essencially the same, except that maize is brought to the plant already dehulled and degermed, and thus it is poured directly into the input hopper of the bucket elevator.

Dehulled, degermed maize grits and dehulled soyabeans are conveyed by inclined screw conveyors from the bulk tanks to the proportioner mill where they are ground and mixed appropriately. The coarsely-ground maize/soyabean mixture is fed to the extruder hopper by a horizontal conveyor. While dropping to the extruder hopper, the mixture is mixed with water, which flows continuously at about 25 liters per hour. The mixture is fed into the extrusion chamber by the use of an injector auger, a device which, apart from the proportional mill, can also be used to control the feed rates of the extruder. Extrusion is usually done at 160-165°C. The extruded product is brought up to the cooler drum through an open belt conveyor. The cooler drum is inclined and is kept rotating towards the finer grinding mill (Prater Mill) to which the product drops by gravity. Cooling of the product in the cooler drum is facilitated with forced air flowing in the same direction with the chips. Ground product from the fine grindi mill is moved by a horizontally-installed screw conveyor. Essentially, the air relief system helps to cool further and remove the product from the grinding mill.

An inclined screw conveyor conveys the ground product to the surge tank which has been installed just above the blender. The important aspect of the surge tank is that it permits periodic batch blending. Material from the surge tank is periodically dropped into the blender by gravity through a controlled opening It is at this point that the NFDM, minerals and vitamins are added to ground, extruded mixture of maize and soyabeans. A single batch blendin period is about 5 minutes. Along with the paddle blender, there is a scale provided for checking the approximate weights of materials which are mixed per batch run.

The final blended product is conveyed by another inclined screw conveyor to a surge tank which is intact with a volumetric packager. Th product is packed by filling it in polybags using the volumetric packager, after which the weight is checked (net weight is 2 kilograms) 4 and the bags are sealed. Then the 2-kg sealed polybags are packed in paper bags (2 kg x 10" each) and stored temporarily in a nearby area. The overall packaging process is done manually.

4/ The 2-kg. bag is only provisional.

Workshop participants toured the three main processing areas of the LISHA plant.

Table I. Approximate Requirements of Raw Materials

	TONS
Maize (Maize grits)	800
Soyabeans	360
Milk (NFDM)	50
Mineral Premix	23
Vitamin Premix	0.85

With the outlined production conditions, Table I indicates the annual requirement of materials, which total approximately 1200 tons.

Up to the end of December 1978, approximately 730 tons of raw materials were used, out of which 572 tons of LISHA were produced. Table II briefly indicates monthly amount of raw materials used, as well as production.

Table II. Raw materials used 1/ and production from May 15th - December 31st

Month	Maize, Maize grits	Soyabeans	Mineral premix	Vitamin premix	NFDM	Finished product (LISHA)
May	52,240	26,880	.180	0.061	--	42.1
June	60,560	23,760	1.275	0.042	3.050	67.4
July	64,310	20,640	1.275	0.035	3.413	71.4
August	67,840	29,420	--	--	3.653	76.3
September	57,360	27,160	.781	0.027	3.408	75.1
October	66,720	21,760	1.738	0.032	3.956	81.8
November	69,840	26,480	1.841	0.047	4.012	84.1
December	63,600	21,040	1.573	0.032	3.473	74.0
TOTAL	502,470	197,140	8.663	.276	24.965	572.2

1/ All figures recorded only for the materials which are filled in bulk tanks.

Table III. Average Physical Analysis - As Part of Quality Control

Raw material moisture (mixture)	11%
Final product moisture	5.5%
Sieve analysis (100 g)	
Wt. retained in #6	0g
Wt. retained in #30	35g
Wt. retained in #60	56g
Wt. retained in pan	9g
Flavor of product	mild corn
Odor of chips	mild
Consistometer	25 cm
Bulk density	0.54g/cc

Production conditions of LISHA for the first year have been designed as follows:

(1) 8-hour production day
(2) 5-day production week
(3) Approximately 38-week production year
(4) Approximately 480-500 kg/hr production rate
(5) 3.8-4.0 tons production daily
(6) 75% production efficiency

Average physical analysis results as part of quality control for the product appear in Table III. So far, results of nutrient analysis have not been obtained.

Recent costings as outlined in Table IV indicate that it costs National Milling Corporation about T.Shs. 2,350.00 5/ per hour to produce 500 kg. of LISHA, i. e., approximately 4.70 Shs. 6/ per kilogram of LISHA.

Apart from the 8-hour 5-day week production, there are some more hours for working around the plant. Approximately 1½ hours 5 days per week are spent on daily maintenance of the machinery as well as cleaning. About 8 hours 1 day per week are used for weekly and monthly maintenance and repairs wherever necessary. Extra hours are also spent on moving and sorting out materials, especially soyabeans and finished product, so that there are always minimum problems when production starts in the following fresh production week as regards the arrangement of materials within the plant.

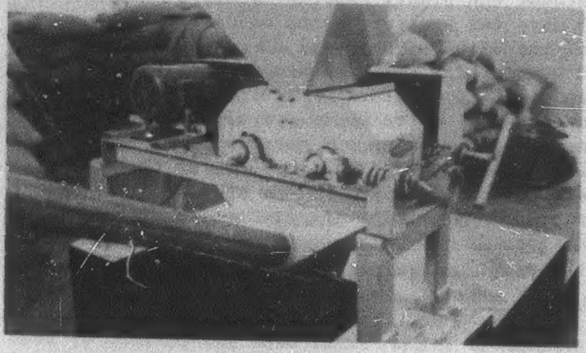
5/ U.S. $317.57.
6/ U.S. $ 0.635.

Table IV. Production Costs

Item	Total quantity obtained or produced/hour	Unit price T.Shs. 1/	Total price T.Shs/hr.
1. Raw materials			
A. Maize grits	350 kg	1.80	630.00
B. Soyabeans	125 kg	4.70	587.50
C. Vitamins	0.4 kg	135.00	54.00
D. Minerals	10.3 kg	17.20	177.00
E. Non-fat dry milk	25 kg	15.00	375.00
2. Packaging materials			
A. Polybags	250	.35	87.00
B. Paper bags	25	4.00	100.00
3. Production			
A. Salaries and wages			84.00
B. Transport	720 kg	0.02	14.40
C. Maintenance and spare parts			6.38
4. Direct costs			
A. Fuel and lubricants	0.18 1 0.01 1	4.85 2.58	0.89
B. Electricity and water	85 kwh 471	.50 .002	42.60
C. Depreciation			10.95
D. Interest			30.00
5. Others			
A. Shrinkage and waste (2%)			43.99
B. Overheads (5%)			109.98
6. Total cost of production			2353.69

1/ T.Shs. 7.40 = U.S. $1.00 (January 1979).

The production cost of 1 kg is approximately T.Shs. 4.71.



Cracking Mill and Screw Conveyor

Dehulling Room in LISHA Plant

Most of the activities and other observations are recorded. During production there is an hourly log sheet filled out by the operators on several important operational parameters and other observations. At the same time, product quality contol is done and recorded by the quality control personnel. Weights of different materials added during batch blending are also recorded. Once in every production week, the type of maintenance and repairs done are also recorded. Replacement records are always compared against spare parts cards, which indicate the type and serial number of the spare parts as well as the amount of remaining stock.

In the case of stores section, there are records based on daily and monthly raw materials and finished product stock returns. In these records the amounts of materials received, used, transferred, produced, rejected and overall opening and closing stocks are indicated. Finally, there is a monthly summarized production record (report) presented by the production supervisor in which the amounts of raw materials used, product produced, total hours spent, hours lost and mechanical and electrical problems are indicated.

The formats and/or systems of keeping records are presented in Figures 2-10.

PROBLEMS ENCOUNTERED

It is eight months since the LEC system at NMC started operating, and we now have some good experience. Several problems, ranging from getting materials for the plant to technical difficulties, have been realized.

1. Getting vitamin and mineral supplies in time before or just when the initial stock is about to end seems to be predominant.
2. Although the plant has been operating, actually there isn't enough stock of spare parts.
3. Dehulling soyabeans by using the cracking mill is not done properly.
4. The injector auger which conveys the maize/ soyabeans mixture occasionally clogs.
5. Rate of wear of the rotors and cones is very high.
6. Power losses have been a special problem not only for the LEC plant but also for other plants around.

FUTURE PLANS

1. In the near future the present 2-kg polybag pack will be abandoned, and appropriate packages of 1-kg and less will be used to suit both feeding programs and various commercial market demands.
2. To produce almost twice the present projected annual production by changing from an 8-hour production to a 16-hour production day.
3. To conduct different tests on different formulations based on other locally-available cereals and legumes in an effort to identify other suitable mixtures for weaning food production using the LEC facility.
4. A fully-established quality control analytical laboratory is also planned. This laboratory will not only cater to the LEC plant, but also to other NMC food production plants.
5. To consult with some of the local engineering firms in an effort to modify and design some of the equipment parts, so as to cut down some of the costs of importing these parts.
6. A diesel-powered electric generator is planned for, to be used as an emergency source of power during electric power supply cuts. The emergency generator also will cater to other plants around.
7. As far as LEC plant personnel are concerned, it is planned that as many as possible will be trained, hopefully with assistance from the U.S.

CONCLUSION

Based on the past eight months' experience and achievements with the LEC plant, we in Tanzania feel that in the near future we can manage the plant with little or no technical assistance from outside, and that the future of producing local high-protein weaning foods lies on the success of this program.

REFERENCE

Tribelhorn, Ronald E. 1976. Colorado State University. Extrusion Facilities and Systems. LEC International Workshop Proceedings, June 2-5.

Date________________________

Date Point										
Time Taken										
1. BRADY EXTRUDER										
A. Brady Ammeter (amps)										
B. Brady temperature (°F)										
C. Feed auger setting										
D. Water addition (kg./min)										
2. MODERN MILL										
A. Proportioner setting										
B. Vari-speed setting										
C. Ammeter (amps)										
3. COOLER										
A. Input product temp. (°C)										
B. Speed of Drum										
C. Outlet product temp. (°C)										
4. PRATER GRINDER MILL										
A. Ammeter (amps)										
B. Output product temp. (°C)										
5. PACKING-BAG SIZE										
A. Bags produced for the day (cumulative)										
B. Broken bags per day										
6. Total Daily Electrical Consumption (Kwatt hrs.)										

MODERN MILL CALIBRATION

INGREDIENT	VARIABLE	DIAL	WEIGHT/MIN.
Corn			
Soyabeans			

Figure 2. Hourly Log Sheet.

Date ____________________

Sample number										
Time taken										
Raw material moisture (2/day)										
Final product, moisture (2/day)										
Sieve analysis (1/day)										
Weight retained in #6										
Weight retained in #30										
Weight retained in #60										
Weight retained in pan										
Flavor of product (hourly)										
Odor of chips (hourly)										
Taste of gruel (hourly)										
Consistometer (hourly)										
Bulk density (1/day)										
Action taken										

SIGNATURE ____________________

Figure 3. Daily Quality Control Report

Number of Blends	CSB (Kgm)	Milk (Kgm)	Vitamin Premix (lbs.)	Mineral Premix (lbs.)
1.				
2.				
3.				

Figure 4. Addition of Milk Powder, Vitamin and Mineral Premixes to CSB.

EQUIPMENT	DAILY	WEEKLY	MONTHLY	YEARLY
Cracking Mill	Grease 4 roller bearings Check belt tension	Repeat daily schedule Gauge belt tension	Grease motor bearings Check wear of rollers	
Screw conveyor	Check bearing wear Check belt tension	Repeat daily schedule Gauge belt tension Check belt wear		
Gravity table	Clean lower air screens Check deck screw for holes Grease 2 drive bearings Check belt tension	Repeat daily schedule Check bearing wear Grease essential drive bearings Gauge belt tension		Grease blower bearing 2 times/year Remove deck and clean machine 2 times/year
Aspirator		Grease bearings Check bearing wear Check belt tension	Clean out aspirator unit	
Elevator		Grease bearings Check bearing wear Gauge tension of drive belts		

Signature____________________
Date____________________
Type of Maintenance____________________

Figure 5. Dehulling Section Maintenance Schedule Check Sheet

Section Name: BABY FOOD PLANT

Batch No.____________________

DATE	DETAILS	ORDER NO.	QUANTITY	UNIT VALUE	BALANCE	REMARKS

Figure 6. Spare Parts Card.

EQUIPMENT	DAILY	WEEKLY	MONTHLY	YEARLY
Incoming screw conveyors	Check belt tension	Check bearing wear Check belt wear Gauge belt tension		
Modern Mill	Grease variable speed pulley Clean magnets	Check variable speed belt wear Check all belt tension Gauge belt tension Check drive belt wear and tension Check bearing wear on computer drive Check oil level of computer drive Check hammer wear Check screen wear		
Brady	Check hydraulic oil level Grease rotor bearing weldment (15 pumps) Check belt tension Check cone bolt tightness Grease universal joints	Grease threads Grease bearings on cone adjustment handle Gauge belt tension Check universal joint bearing wear Check main bearing wear Check cup retainer bolts Check cylinder rib bolts Check cone wear Check rotor wear Change rotor, cup and cone	Change oil filter	Change hydraulic oil 2 times per year Grease motor 2 times per year Check brush wear 2 times per year
Belt Conveyor	Check bearing wear Grease bearings	Gauge belt tension Check bearing wear Check belt wear		
Cooler		Check oil level gear box-SAE 90 Check bearing wear		Grease bearing one time per year
Prater Mill	Clean magnet	Check hammers Check screen wear Check bearing wear		Grease motor bearings one time/year Grease bearing on mill twice per year
Blower		Check bearing wear Check and gauge belt tension		
Screw Conveyor (Final product conveyor)		Check bearing wear Gauge belt tension	Grease bearing	
Marion Mixer (blender)	Check belt tension Lubricate chain Clean out the blending chamber	Check bearing wear Check and gauge belt tension Clean and lubricate chain Wash (clean) blending chamber Adjust clearances of blades	Grease bearing	
Screw conveyor (Final product conveyor)	Check bearing wear	Gauge belt tension Check bearing wear Check belt wear		

Figure 7. Processing Section Maintenance Schedule Check Sheet

Daily and Monthly____________________ NO:.____________________

Raw Materials	Opening Stock		Receipts		Sales		Transfers		Used		Balance	
Minerals	Drums	Kgs	Drums	Kgs	Drums	Kgs	Drums	Kgs	Drums	Kgs	Drums	Kgs
Vitamins	Drums	Kgs	Drums	Kgs	Drums	Kgs	Drums	Kgs	Drums	Kgs	Drums	Kgs
Soyabeans	Bags	Kgs	Bags	Kgs	Bags	Kgs	Bags	Kgs	Bags	Kgs	Bags	Kgs
Maize Grits	Bags	Kgs	Bags	Kgs	Bags	Kgs	Bags	Kgs	Bags	Kgs	Bags	Kgs
Milk Powder	P. bags	Kgs	P. bags	Kgs	P. bags	Kgs	P. bags	Kgs	P. bags	Kgs	P. bags	Kgs

Signature____________________

Date____________________

Figure 8. Baby.Food Plant Raw Materials Stocks Return.

Monthly Report____________________

Raw Material Stock	Minerals	Vitamins	Soyabeans	Maize	Milk			Production		
	Kgs	Kgs	Kgs	Kgs	Kgs	Kgs	Kgs	Lisha	Carton	Kgs
Opening stock										
Add receipts								10 x 2 kgs		
Less sales								10 x 1½"		
Less transfers										
Less used								Total		
Closing stock theory								Hours worked		
Physical stock								Budget		
								Actual		
								Lost		

Production Verified by:____________________
Signature____________________
DATE____________________

Figure 9. Raw Material Stock and Production Return.

Item	Kgs	Opening stock	Mill	Receipts smalls	Sales	Issued transfers	Closing theory	Stock actual	Difference
Lisha									
Lisha rejected and sweepings									
Corn Bran									
Soya Bran									

Date________________________________

Signature___________________________

Figure 10. Baby Food Plant Finished Products Control Return.

Moderator:

Dr. Alvin Siegel
INTSOY
University of Illinois at Urbana-Champaign

Dr. Harper:

Have you done a cost analysis, Mr. Kepakepa, to determine what your production costs per kilogram have been? You stated some numbers, but I didn't get them clearly when you were giving your paper.

Mr. Kepakepa:

We have done several cost analyses, but we haven't come up with a final one. The cost right now is approximately 60 cents (U. S.) per kilogram. It is more than $300 per hour for production costs.

Dr. Harper:

When you say 60¢ (US) per kilogram, can you give an approximate breakdown on how much of that is ingredient costs, how much is labor costs, packaging costs, repairs, etc?

Mr. Kepakepa:

Production costs are based on production per hour. Staring with raw materials, a kilo of maize grits (350 kilos) costs about 1 shilling and 80 cents (Tanzanian) or a total of 630 shillings. 1/ Soybeans (125 kilos) cost about 4 shillings and 70 cents, or a total of 587 shillings and 50 cents. We used about 0.4 kilos per hour of vitamin premix and it cost about 13.5 shillings per kilo, or a total of 54 shillings. We used about 10.3 kilograms per hour of minerals and they cost 17 shillings. Nonfat dry milk used was 25 kilograms per hour, costing 15 shillings, or a total of 375 shillings.

Packaging materials: ploybags, which we use at the rate of about 250 bags per hour, cost 55 cents per 40 bags, or a total of 87 shillings. Then the paper bags cost 4 shillings each, and we use about 25 per hour, for a total of 100 shillings.

Salaries and wages: 84 shillings per hour.

Transport: approximately 720 kilograms per hour, and it costs about 0.2 cents per kilogram, or a total of 14 shillings and 40 cents per hour.

Maintenance and spare parts: 42 shillings and 55 cents per hour.

Fuel and lubricants: fuel use is 0.18 liters per hour (transmission oil for the Brady, Modern mill and drum cooler) and lubricant use is 0.01 liters. The fuel costs us about 4 shillings and 85 cents per liter, and the lubricants cost us about 2 shillings and 50 cents per liter, or a total for both costs of 0.89 cents per hour.

Electricity and water: we use about 85 kilowatt hours per hour, and 1 kilowatt hour of electricity costs approximately 50 cents. The water use is 47 liters per hour, and it costs 0.002 cents per liter of water--it is pretty cheap. The total cost of electricity is 42 shillings and 60 cents per hour.

Depreciation: machinery depreciation is 10 shillings and 93 cents per hour.

Interest: 30 shillings.

All figures are in Tanzanian shillings. We found that shrinkage and waste was about 2 percent, or 44 shillings and 71 cents. The overhead costs--they are high here--are about 5 percent, or 111 shillings and 78 cents.

Total: 2,392 shillings and 18 cents per hour for 500 kilos.

Dr. Siegel:

With regard to Mr. Mosha's point on dehulling efficiency, I think we have to look at the condition of the soybeans and their moisture content. Also, I think this can be improved from an equipment standpoint.

Mr. Nave:

Everybody seems to be so concerned with dehulling, and I--in eighteen years of association with this--have yet to see any reason for dehulling from a nutritional point of view. I can see it from a mechanical point

---

1/ 1 Tanzania Shilling = U.S. $0.135.

of view and I can see it from a suspension point of view, but for any baby two days old or more, I see no reason for dehulling soybeans. We have fed them to lots of babies--some of them as young as two days old--without dehulling and with no ill effects. And I have seen no literature or anything that says that a little bit of hull in there, finely ground, makes one speck of difference to a baby and its digestive system.

Dr. Siegel:

I am wondering if the dehulling point relates to the wear of the machinery.

Mr. Nave:

I think that is a justifiable thought to consider, but nutritionally I haven't seen any evidence for it--maybe somebody else has.

Dr. Jansen:

I am going to talk on nutritional issues a little later, and there will be some time to discuss this fiber issue. I think you have to realize that the normal diet of a very young infant is fiber-free--it is high fat and very digestible--and I think there are some significant reasons to be concerned with fiber. It is a matter of degree, and I believe it is premature to say that one should go right into completely hulled products and feed them to a very young child. I would be very reluctant to recommend that.

Dr. Siegel:

I would just like to ask the National Milling Corporation to enlarge on your maintenance program. Is there a fixed sanitation program as a control for this type of thing?

Mr. Kepakepa:

He is asking about the sanitation and pest control program. National Milling as such has an overall program for sanitation control. But it is not working effectively, and we are considering reorganizing it.

Mrs. Gobezie:

I would like to know the relationship between the Tanzania Food and Nutrition Center and the National Milling Corporation?

Mr. Kepakepa:

In this country most of the institutions and corporations are government-owned, and in most cases the type of product you are making is recommended for use by another corporation. In this case, Tanzania Food and Nutrition Center is an institution dealing mainly with food development and so forth, whereas National Milling Corporation is the main grain-handling institution. Tanzania Food and Nutrition Center--they do not produce, as does National Milling Corporation--determines that the product is a useful thing and is for the benefit of this country. So both institutions are cooperating in this program.

Mr. Bleyer:

How many times have the screw augers been opened for cleaning?

Mr. Kepakepa:

We have opened them due to mechanical problems and we then clean them, as well. I can't tell you exactly, but I know we have done this several times. The screw conveyor within the U-trough is opened once every week and cleaned.

Mr. Tribelhorn:

I just wanted to say something about the wear of the extruder components and what CSU has been doing. We have been instituting procedures in the existing plants to reduce some of the wear problems, including rebuilding wearable components by hard surfacing. The problem of wear has been a continual problem since the project began, and I think we have made some progress on it. This would seem to be an appropriate topic to discuss during the work group sessions later this week.

The Food for Peace Program [1]

H. Peters Strong
Regional Food for Peace Office
U.S. Agency for International Development
Nairobi, Kenya

LEGISLATION

e Food for Peace Program was first authorized
the Congress under the Agricultural Trade
velopment and Assistance Act of 1954, known as
blic Law 480. The original program was
imarily a vehicle to dispose of domestic com-
dity surplus. This emphasis changed in 1966
en the Congress declared it to be U.S. policy
use its abundant agricultural productivity
carry out the multiple purposes of the Act.
ese include combatting hunger and malnutrition,
couraging economic development, expansion of
port markets and to promote in other ways the
reign policy of the United States.

e International Development and Food Assistance
t of 1977 and the Omnibus Farm Bill of 1977
hich extended the program for four years -
rough December 31, 1981) further emphasized
at P.L. 480 resources should be used to help
or countries in their development efforts. In
l cases, it must be determined that food on
ncessional terms is needed, that adequate
cal storage facilities are available and that
od aid will not result in a substantial dis-
centive to the recipient country's food pro-
ction. P.L. 480 programs are integrated as
osely as possible with activities supported
A.I.D. and other aid donors, including
ltilateral lending institutions.

. PROGRAM COMPONENTS

L. 480 consists of two parts--concessional
les of agricultural commodities to friendly
untries under Titles I and III and donation
food under Title II.

Title I.

Title I authorizes sales of U.S. agricultural commodities to friendly countries on a long-term dollar-repayable basis. The maximum repayment terms are 40 years maturity, with a 10-year grace period at 2 percent interest and 3 percent interest thereafter. In practice, an initial payment of at least 5 percent in dollars is usually required--i.e., if an initial payment of 5 percent is required, USDA finances only 95 percent of the cost of the commodities purchased under the agreement. If the U.S. needs local currency for its official expenses, an early payment (5-20 percent) in local currency may also be required. These "currency use payments" are credited as advance payments of the earliest installments due under the loan. Loan repayments and dollar proceeds from sales of local currency are returned to CCC.

Commodities are sold by U.S. private exporters at commercial market prices to the recipient countries. USDA finances these sales and absorbs the cost of the ocean freight differential, if any, for the 50 percent of cargo which is required to be carried in U.S. flag vessels. Reasonable precautions must be taken to safeguard usual marketing of the U.S. and avoid disrupting normal patterns of commercial trade with friendly countries. Consequently, most Title I agreements require the recipient country to maintain specific levels of commercial purchases of the commodities included in the agreement. This provision is known as "Usual Marketing Requirements" (UMR). The local currency proceeds from the sale of the Title I commodities in the recipient country are used to support economic development activities in the country. Particular emphasis is placed on agricultural and rural development, nutrition and population planning projects in poor rural areas.

The legislation requires that at least 75 percent of the volume of Title I food aid initially be allocated to countries whose per capita income is at or below the poverty criterion of the International Development Association (IDA). After the initial allocation, food aid may be reallocated, but (so far as practicable) in accordance with the 75/25 requirement if it is found that certification to food assistance is required for humanitarian purposes by "richer" countries; or if circumstances change significantly so that "poorer" countries cannot use the food effectively. Title I allocations must be reported to the Congress each quarter.

No Title I agreement may be entered into with any country which engages in a consistent pattern of gross violations of internationally recognized human rights unless the commodities themselves or the sale proceeds will be used to directly benefit the needy.

/ Paper received subsequent to workshop for
nclusion in Proceedings in lieu of Mr. Strong's
formal remarks.

B. Title III

Food for Development programs authorized under Title III (but funded under Title I) offer a substantial incentive for countries to undertake additional development programs to improve the quality of life for poor people, particularly in rural areas. Countries wishing to participate must formulate a multi-year development plan for the intended use of the commodities or the proceeds to implement new policies where appropriate and to help identify and remove the constraints to equitable expansion of food production and consumption and equitable growth.

The U.S. may enter into multi-year supply commitments of up to five years which assure countries that they have priority access to P.L. 480 food subject to an annual review of progress achieved under the program. Local currencies generated through sales of Food for Peace commodities which are used to support agreed-upon development efforts may be credited against dollars which would otherwise have to be repaid to the United States.

The legislation provides that for FY 1979 Title III shall comprise not less than 10 percent of the aggregate value of Title I agreements. This will rise to 15 percent in FY 1980 and thereafter; however, under certain circumstances the equivalent may be waived.

C. Title II

Title II authorized donations of food to meet famine or other urgent or extraordinary relief requirements to combat malnutrition (especially in children) and to promote economic and community development. Title II programs are designed to supplement and reinforce other developmental and nutritional activities. These programs are conducted within a framework of increasing local management and funding. As Title II food is distributed to meet the basic needs of the poor, it is intended to be supportive of human rights. USDA finances the cost of processing, fortifying, packaging, and shipping of the commodities, including delivery to points of land-locked countries. The recipient government usually finances the internal costs of the food distribution program, e.g., warehousing, internal transportation and administration.

A major priority of Title II is helping to meet the nutritional needs of vulnerable groups. Aside from disaster relief, priority is given to Maternal/Child Health programs including pre-school feeding; food-for-work; and primary school feeding. Most commodities used in nutrition programs are now blended and fortified with nutrients. Staples are combined with protein-rich food to make such products as soy-fortified grits and corn-soy milk. New commodities are first screened by the USDA Committee on Processed Foods. This committee determines whether the proposed commodity meets U.S. standards regarding nutritional value, composition, cost effectiveness and cultural acceptability. The stability of the product for long-distance transport, storage and distribution is also evaluated. Final approval is given by the Commodity Credit Corporation. Since the late sixties, there has been much research devoted to the development of low-cost highly nutritious foods. As a result of these studies and field tests, there are currently four blended foods and six fortified foods available under P.L. 480 Title II Programs.

The Congress has established an annual minimum tonnage, 1.6 million metric tons of agricultural commodities for Title II, provided that this amount does not exceed the total availability for P.L. 480.

One of the best opportunities to combine Title II food distribution with other developmental programs is through the activities of U.S. voluntary agencies such as the Cooperative for American Relief Everywhere (CARE), Catholic Relief Services (CRS), and other church-related agencies. To the extent practicable non-profit voluntary agencies registered with and approved by the Advisory Committee on Voluntary Foreign Aid must be utilized. Currently, these agencies receive over half of the Title II donations.

Other Title II donations are made through the World Food Program and through recipient governments. The World Food Program (WFP), sponsored by the United Nations and the FAO., is a multilateral food aid activity to which the U.S. and other donors contribute. The administration of the program is the responsibility of the WFP, under the guidance of the Committee on Food Aid Policies and Programs (CFA), of which the U.S. is a member.

Government-to-government programs consist of donations made directly to another government under the terms of bilateral agreements. Such programs are the product of U.S.A.I.D. Mission and host government planning, and follow the same approval process required of the voluntary agency programs. Once approved, the programs are administered by an entity of the host government, usually one of the ministries, which is responsible for warehousing, inland transportation, and other administrative activities. Originally one of the principal methods of donation transfer, government-to-government programs are now mainly used in emergency feeding and disaster relief.

Executive Order 10900, issued in January 1961, delegates major administrative responsibilities for P.L. 480 to the Departments of Agriculture, State, Treasury, and the Office of Management and Budget. All functions not specifically delegated remain with USDA. All functions under the Act are subject to the responsibilities of the Secretary of State with respect to foreign policy. The Department of State redelegated most of its P.L. 480 responsibilites to A.I.D., including the function of authorizing negotiations of Title I agreements, subject to certain concurrencies by State. The function of administering the Title II donation program was also delegated to the A.I.D. Administrator.

The administration of P.L. 480 is an interagency responsibility. Coordination and reconciliation of various individual agency interest is achieved within the framework of the delegations of authority indicated above by the Food Aid Subcommittee of the Development Coordinating Committee, chaired by USDA. Its membership includes USDA, OMB, Treasury, Commerce and State/A.I.D. The Office of Food for Peace, AID, is responsible for developing and coordinating the State/AID position on each program with the A.I.D. Regional Bureaus, State's Bureau of Economic and Business Affairs and others as appropriate. All P.L. 480 programs are reviewed and approved by the Food Aid Subcommittee.

IV. PROGRAM MAGNITUDE

The P.L. 480 legislation limits the value of Title I and III agreements in any calendar year to $1.9 billion, plus carryover (in terms of reimbursement to the CCC) and Title II programs to $750 million, plus carry-over from the preceding calendar year. Annual expenditure limitations are established in the President's budget and by the Congress. In recent years, the expenditure limitation has been approximately $800 million for Title I and $450 million for Title II.

V. BUDGET ACTIVITIES

The Secretary of Agriculture determines the amounts and kinds of commodities available for P.L. 480. No commodities may be available for P.L. 480 financing if such exports would reduce supplies below the amount needed for domestic consumption, adequate carry-over and anticipated sales for dollar levels, unless the Secretary determines that some part of the supply should be used to carry out urgent humanitarian purposes of the Act--specifically under Title II.

When the commodity availability list is received and the fiscal year budget limitation has been set, specific commodity requirements are submitted from the field. In the case of Title I (which as noted above includes Title III), the proposed country programs reflect an assessment of several factors including: (a) the balance of payments situation; (b) the need for food and the country's ability to use food aid to promote development, particularly in the rural sector; and (c) the relationship of Title I to A.I.D. programs. Human rights and foreign policy concerns are also taken into account.

The Title II requests include estimated requirements for programs sponsored by U.S. voluntary agencies, recipient governments, the World Food Program, and an emergency/unallocated reserve, principally for disaster relief.

VI. PROGRAM OPERATIONS

Title I and III agreements are negotiated in the field by a team under the direction of the U.S. Ambassador. After the agreement is signed, USDA issues purchase authorizations (PAs) which specify the quantity and dollar value of the commodity and contracting and delivery period. Recipient governments buy the commodities from private exporters in the U.S. This process is subject to price review by the USDA. In addition, bookings of shipments are reviewed by USDA since P.L. 480 is subject to the Cargo Preference legislation which requires that at least 50 percent of the cargo be carried on U.S. flag vessels to the extent that such vessels are available at fair and reasonable rates for U.S.-flag commercial vessels. Title I commodities are sold in the recipient countries through private trade channels or, in some cases, are made available through fair price shops or similar arrangements.

For Title II, cooperating sponsors are advised of annual program approval levels and are authorized to submit orders quarterly against these quantities. USDA, in turn, invites bids each month from private industry on all processed foods. Quality control tests are performed by USDA to insure that commodity composition and characteristics conform to official manufacturing specifications as published by USDA. A.I.D. Missions monitor commodity shipments and the management of both

U.S. voluntary agencies' programs and those of other governments. A.I.D. Missions also make recommendations concerning programs carried out by WFP.

VII. LOCALLY-PRODUCED FOODS

A number of countries, like Tanzania, are interested in developing their own processed foods for feeding programs. Often such desires are not based on just economic factors, but also on a desire to "do it themselves." Our approach in such cases should be to support them in achieving their own goals, and I would cite as an excellent example of this the work being done here by AID/USDA and Colorado State University. Not only have they assisted the National Milling Corporation along the road to self-reliance by helping them to develop the capability to produce the "LISHA" baby food, they have at the same time demonstrated a successful transfer of appropriate technology--that of low-cost extrusion cooking.

Locally-available, low-cost extrusion facilities meet several needs. First, they allow a country to supplement or mix imported foods with locally-processed food (this is important because it gives that country a chance to try out such techniques and utilize any recent technology in agricultural production). Second, they allow for a stretching of imported food resources to meet wider requirements. Third, a great deal of on-site technical training and infrastructure-building is accomplished with the introduction of such a facility. Finally, the development of extrusion facilities can easily become an important element in rural development on a micro-scale: serving as an extension of the agricultural marketing process, training technicians and providing employment, generating funds for local health and nutrition activities, and strengthening local involvement in feeding programs. At least some part of each of these needs has already been met in Tanzania; we shall watch with supportive interest the efforts to achieve the remainder.

The LEC Program in Guyana (Part A)

Leslie Chin
Guyana Pharmaceutical Corp., Ltd.
Georgetown, Guyana

INTRODUCTION

Guyana is a former British colony on the tropical north coast of South America. It has an area of 215,000 km^2 and a population of 840,000. Its per caput GNP in 1976 was estimated at U.S. $500. It is a country of 6 races, the two major ones descended from indentured East Indians and African slaves.

USE OF LEC TECHNOLOGY

A 1971 Food and Nutrition Survey in Guyana (PAHO 1976) showed that in the age group 0-5 years, 45% of children are malnourished, 15% are moderately malnourished and 1.7% are severely malnourished. One strategy to reduce the level of malnutrition is to produce and make available a low-cost weaning food. The Guyana Pharmaceutical Corporation (GPC), a state agency, was identified by the government in March 1977 as the organization responsible for the production of a weaning food.

Initial product development work involved drum drying, but a visit by GPC staff to Guatemala and Costa Rica, where the Brady extrusion cooker was observed, convinced GPC of the suitability of the process for the production of a weaning food cereal. Immediate action was taken to order a Brady cooker for product development.

The main objective of the Government of Guyana (GOG) was to produce and make available a low-cost infant cereal as a contribution to the solution of the problem of a high incidence of protein-energy malnutrition in pre-school children. LEC technology has provided answers to problems, e.g., relatively low capital investment and a certain amount of heat treatment to destroy the anti-nutritional factors present in the beans, which are part of the formulation.

One of the spin-offs in the use of LEC technology for the production of a weaning food is its use for the production of:

(a) A puffed breakfast cereal which would partially replace bread made from imported wheat.

(b) An instant pea soup.

(c) Snack foods.

The breakfast cereal will be launched in January 1979, and the pea soup in February 1979.

CURRENT STATUS OF LEC ACTIVITIES

Weaning Food

The weaning food is being developed to reduce the level of protein-energy malnutrition in the 4-months-to-5-years age group.

The specified primary target market should be the malnourished children in the 4-months-to-2-years age group. The following strategies are being adopted to segment the market and so reach this target group directly or indirectly:

(a) Fifteen-to-twenty percent of the total production will be distributed free through the Maternal Child Health Clinics, with priority being given to the mothers of malnourished children.

(b) The product will be low-cost (16¢ U.S. per 227-gram packet or 8.70/kg) to reach the lower-income population, which, as one expects, has a much higher incidence of protein-energy malnutrition. At this price the lowest-income mother will be spending the amount of money per week on weaning food she presently does on current alternatives. This price is also about 2½-to-3 times the price of basic staples like wheat flour and rice.

(c) The product will be labeled "Baby" cereal in order to minimize the problem of the food being shared by the entire family and so preventing the target child from getting its prescribed amount.

(d) The mother is recognized as making the buying decisions for a baby cereal, and promotion will be targeted at her.

Product planning considerations

(a) Organoleptic acceptance, e.g., mouth-feel was identified for panel evaluation, since some initial reactions claimed that the cooked product in porridge form had a gritty mouth-feel.

(b) Cultural acceptance of the ingredients and the final form in which the product is consumed. Eighty percent of children consume porridge (PAHO 1976: Scien. Pub. No. 323).

(c) The product should be easy to prepare with a minimum of cooking time. LEC technology provides an adequate answer by pre-cooking the product.

(d) At the same time, it is considered most desirable to recommend some cooking, say 3-to-5 minutes, in order to ensure that problems related to the microbiological quality of water used in cooking would be eliminated.

Acceptability testing of the product has proceeded through:

(a) Panel testing of a number of alternative formulations.

(b) In-home testing, in which the product was left at home with mothers to try and to later give their reactions.

(c) A mini-market test lasting 3 months. This is now in progress in 10 retail outlets in which the product is being sold. The acceptability of the package, the instructions on the package, the price, the distribution system and the product itself are being evaluated in this mini-market test.

There should be opportunity to make last-minute changes before the final launch if necessary.

(d) During the actual market launch and thereafter, monitoring systems must be maintained to ensure that the product is reaching the target groups.

Packaging is as important as the product in marketing. A number of factors went into the decision to have a plastic pouch.

(a) It is low-cost. This is necessary since the target group is the low-income mothers.

(b) A nylon-polyethylene laminate was chosen since it is considerably stronger than simple polyethylene.

(c) The package will be attractively printed.

(d) The 227-gram pouches will be packed in multi-wall paper sacks, 60 per sack. These sacks will provide a significant protection against rodents which are a major problem. This limited protection will be for storage in the production warehouse, the wholesalers' bonds and the retailers' back-stores. The choice of outer packaging was based on cost-benefit considerations.

(e) Display boxes made out of sturdy material will be provided to retailers for shelf display of the product, in order to protect most of the products except the front package from rodent attack.

Distribution

The distribution channels to be used for the baby cereal are the established ones being currently used by the producer, Guyana Pharmaceutical Corporation, in its distribution of over-the-counter drugs, toiletries and food essences. Ninety percent of retailers are reached by this distribution system, which is a combination of a wholesaler/retailer chain and direct selling to retailers.

As mentioned earlier 15-to-20 percent of the total production will be distributed freely by the Ministry of Health through its 134 Health Clinics. Actual distribution from the factory will be done by the Ministry of Health's Central Food Unit, which is responsible for the distribution of food supplements.

Pricing

Effective pricing is most important in order to reach the target market. This is being achieved by a number of approaches.

(a) About 75 percent of the food ingredients are being donated through USAID during the first phase of 3 years of this project.

(b) The remaining 25 percent of the food ingredients will be donated by the Government of Guyana.

(c) The packaging materials are being donated by the USAID in the first 3 years.

(d) The capital equipment is being donated by USAID.

(e) The building for the factory is being donated by the Government of Guyana.

In the second phase, in which there is going to be a phasing out of the external assistance, it is expected that, with increased production throughput including the production of other extruder-based foods such as puffed breakfast cereals, pea soups and snack foods, the cost per unit production will be lowered. In a commercially self-sustaining operation, it is expected that the price of the product would not increase by more than 60 per cent.

The LEC Program in Guyana (Part B)

Vickram Oditt
Guyana Pharmaceutical Corp., Ltd.
Georgetown, Guyana

I. PRODUCT AND PROCESS DEVELOPMENT ACTIVITIES

Ingredient selection and their availability

We have the objective in Guyana of using indigenous or potentially available raw materials as ingredients in our food products.

The main ingredients in our weaning food product are: corn, rice, soybean (toasted defatted flour and oil), skim milk powder and sugar. Of these, only skim milk powder will not be available locally in the immediate future. This ingredient has been included, however, because large quantities of it are donated to the GOG on an ongoing basis by various international agencies and foreign countries.

The main ingredients used in our breakfast cereal product are: corn, soybean and sugar, and there is no problem with availability here. Similarly, indigenous black-eyed peas, corn, rice and soybean form the base of our instant pea soup product.

Selection of equipment

Guyana Pharmaceutical Corporation will have two LEC plants in operation for the processing of our various food products.

One plant is being donated by USAID/Guyana for the manufacture of our weaning food. Specifications for the plant equipment have been worked out in collaboration with our technical advisors from Colorado State University, and this equipment is now being ordered by GPC.

Our other LEC plant will be used for the breakfast cereal and instant pea soup products. The Brady cooker we currently operate will be incorporated into this plant, and the remaining pieces of equipment will be bought or manufactured in Guyana.

Plant layout

The proposed floor plan for the weaning food plant is shown in Figure 1, while a plant flow diagram is shown in Figure 2. It can be seen that the sequence of equipment is similar to that of LEC plants that have been installed in other countries. The total cost of the plant equipment plus spare parts for one year landed in Guyana is approximately $160,000.

Essentially the processing system has been designed to:

a. cook a corn/rice/soybean oil mixture using a Brady extrusion cooker;

b. grind the cooked product and blend it with skim milk powder, toasted defatted soy flour, sugar, vitamins and minerals;

c. package the blended food in 227-g attractively-printed laminated bags.

Nutritional considerations

The formulation of our weaning food product "Cerex" is as follows:

Percentage	Ingredient
36	cornmeal (degermed)
15	white rice (broken)
20	soy flour (defatted, toasted)
7	soy oil (salad grade)
10	white sugar
1.9	mineral premix
0.1	vitamin premix
10	skim milk powder

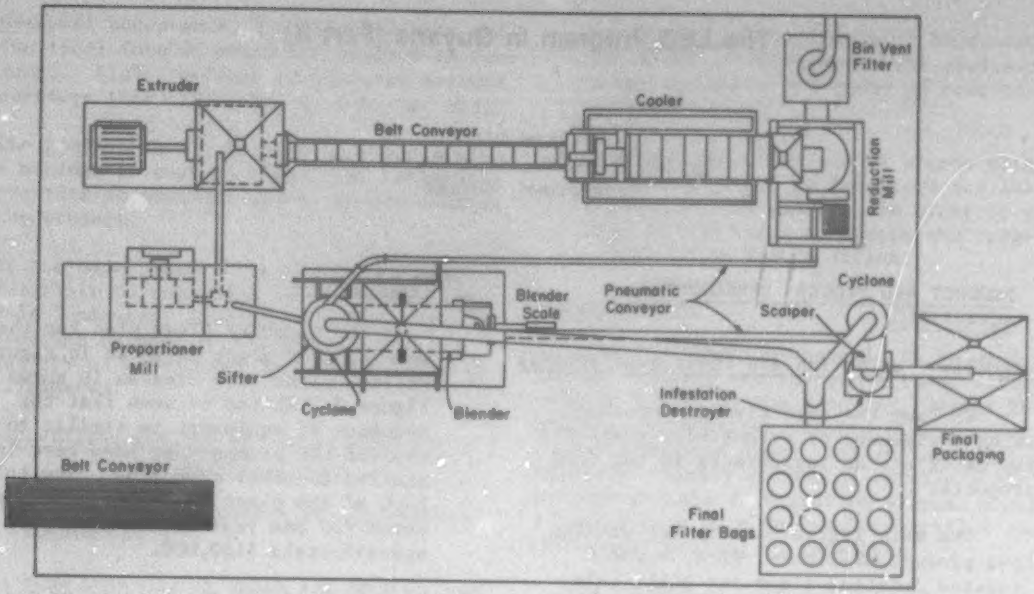

Bin Vent Filter
Extruder
Cooler
Belt Conveyor
Reduction Mill
Blender Scale
Pneumatic Conveyor
Cyclone
Scalper
Proportioner Mill
Sifter
Cyclone
Blender
Infestation Destroyer
Final Packaging
Belt Conveyor
Final Filter Bags

Figure 1. Floor plan of Guyana Pharmaceutical Corporation plant.

The nutritional composition per 100 g is as follows:

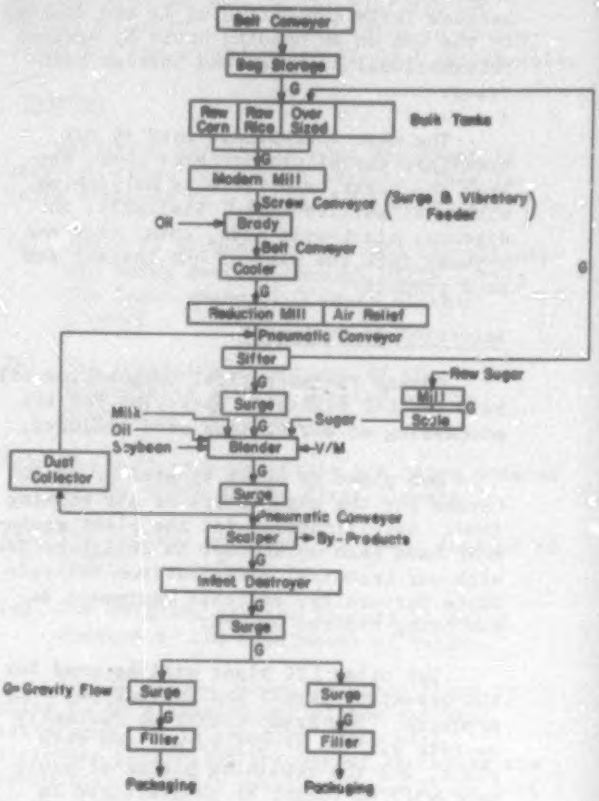
Energy content	92 kJ (387 k. cals.)
Protein	17 g
Fat	8 g

From a nutritional point of view this product is similar to CSM. Detailed analyses (including animal feeding experiments) and storageability tests are being done at the Department of Food Science and Nutrition of CSU.

Two infant feeding trials have been planned for the product before it goes into full production. The first is in progress at the Tropical Metabolism Research Unit of the University of the West Indies in Jamaica, West Indies. The second will take place in Guyana with the assistance of the Ministry of Health.

II. SHORT AND LONG TERM PRODUCTION GOALS

Guyana's weaning food plant is expected to begin operations in August 1979, and the production goal for 1979 is 215 M.T. It is estimated, however, that 850 M.T. per annum would be our full market potential, based on the projected per capita consumption of infants in the 4-months-to-5-years age group. It is expected that this full market potential would be reached in 1983.


Belt Conveyor
Bag Storage
G
Raw Corn
Raw Rice
Over Sized
Bulk Tanks
G
Modern Mill
Screw Conveyor (Surge & Vibratory Feeder)
Oil
Brady
Belt Conveyor
Cooler
G
G
Reduction Mill
Air Relief
Pneumatic Conveyor
Sifter
G
Raw Sugar
Mill
G
Surge
Milk
Oil
Soybean
G
Sugar
Scale
Blender
V/M
Dust Collector
G
Surge
Pneumatic Conveyor
Scalper
By-Products
G
Infest Destroyer
G
Surge
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G=Gravity Flow
Surge
Surge
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Filler
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Packaging
Packaging

Figure 2. Preliminary plant flow diagram.

GPC's breakfast cereal/instant soup plant is expected to produce 250 M.T. in 1979 and to achieve a production goal of 900 M.T. in 1983.

III. FUTURE PLANS FOR PRODUCT MODIFICATION

There are no immediate plans for modifications to our weaning food product. Any future modification would be based on results obtained from market tests, nutritional analyses or infant feeding trials.

In the breakfast cereal range, GPC has plans to manufacture a rice-based product within 9 months. In addition, there are proposals to utilize wheat bran from the local flour mill to manufacture another breakfast cereal product.

GPC's plans for modification of our instant pea soup product would include the manufacture of other flavored instant soups. One example of this type of soup would be instant chicken-flavored soup, which has a high market demand in Guyana.

Another range of products in which GPC is interested is snack foods. In this respect, the possibility of purchasing a LEC that can produce shaped snacks is being investigated.

GPC packages its baby cereal in 227-g pouches.

Review of the Honduras Program

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TRODUCTION

Honduras is a country with approximately % of its population suffering some degree of lnutrition (Consuplane, 1978). Available data so indicate that in 1977, of the total of 3,000 children under five years of age, 75% 490,000 were suffering some form of malnutri- on, and 29% or 190,000 of all children under ve were suffering from moderate to severe lnutrition. The bulk of the most severe cases s found within these 190,000 children, or with- this 6% of the country's total population. other recent study (Flores, 1977), which in- lved a survey of food intake by low socioecono- c groups in rural areas, has also revealed at nutrient intake by pre-school children is astically below the recommended nutrient in- ke (RNI) in calories, retinol, riboflavin and d niacin; therefore, it is potentially con- cive to severe cases of malnutrition (Table I). e adult diet also had considerable deficien- ies (Table II); however, as far as adequacy of trient intake, the worst diets were found a- ng pre-school children.

Obviously the malnutrition problem is evere; however, now that a clear diagnosis of e nutrition situation of the population is vailable, it is expected that food and nutrition rograms will be designed more efficiently. urthermore, SAPLAN (National System for Food nd Nutrition Planning), the foremost authority n nutritional planning, is well aware that aximum efficiency in the country's nutritional rojects can only be obtained by an interinsti- utional and interdisciplinary approach to the roblem. SAPLAN states in the National Plan of ood and Nutrition (NPFN, 1979-1983) that to ackle malnutrition it is necessary, among other hings, to increase the availability of food rops, obtain a better distribution of income, mprove rural health care (preventive and cura- ive), promote the nutritional education of the ayman and improve the efficiency in the distri- ution of complementary foods (Consuplane, 1978).

On the subject of supplementary feeding the PFN describes the local production of Maisoy (Corn/Soy Blend) as a project of top priority, asically because there is a strong desire to roduce a low-cost food so formulated as to supplement the Honduran diet with its most deficient nutrients. A review of the progress to date for the Maisoy processing facility follows.

HISTORICAL OVERVIEW

The first extrusion equipment (Brady) tested in Central America to produce low-cost nutritious foods was loaned in 1975 by CARE/USAID to the Institute of Nutrition of Central America and Panama (INCAP), and since then considerable research has been undertaken to optimize the running parameters of the extruder, so as to obtain food systems with the best nutritional, organoleptic and storage stability properties. Of the many food mixtures tested (Table III), the Maisoy formula (70 parts corn/30 parts soybeans) has been considered the best mixture for Hondurans, basically because it has a high nutritional value, a relatively low-cost, and a flavor somewhat similar to cooked corn flour (atole), a staple food in the traditional Honduran diet.

Interest in the possibility of establishing a Maisoy processing facility was high in 1975, and by the end of that year a prototype processing facility was proposed by INCAP (Bressani, 1976). Likewise, in the same year, an extensive acceptability trial was conducted in various communities in Hounduas. The acceptability trial was efficiently conducted by PANI (National Children's Foundation), INCAP and British nutritionists with highly encouraging results (Table IV). A pre-feasibility study which also indicated the soundness of the project was performed in the same year.

As it can clearly be seen, substantial efforts were undertaken in 1975 to promote the establishment of the Maisoy processing facility. However, implementation of the project was delayed primarily because of the lack of capital and the unavailability of locally-grown soybeans. Only recently (April, 1978) has the project restarted because of three major reasons:

1. Soybeans are being produced locally in sufficient quantities by a program sponsored by the Ministry of Natural Resources (Table V).

Table I. Daily Nutrient Intake and its Percent of Adequacy in the Diet of Honduran Rural Pre-School Children Classified According to Socioeconomic Groups (ages 3-6)

NUTRIENT	SOCIOECONOMIC GROUPS 1/								
	LOW			MIDDLE			HIGH		
	$\bar{X}$ 2/	SD 3/	% 4/ RNI	$\bar{X}$	SD	RNI	$\bar{X}$	SD	RNI
Calories (units)	732	± 278	42	833	± 308	48	1125	± 400	64
Total Protein (g)	23.2	± 9.7	70	24.2	± 9.1	73	37.5	± 13.1	113
Calcium (mg)	401	± 258	89	505	± 272	112	999	± 580	222
Iron (mg)	6.5	± 5.0	65^{+}	5.4	± 3.0	54	5.1	± 2.4	51
Retinol equivalents (mg)	112		37	100		33	237		79
Thiamine (mg)	0.40	± 0.20	57^{+}	0.40	± 0.17	57	0.53	± 0.19	75
Riboflavin (mg)	0.37	± 0.21	37^{+}	0.56	± 0.37	56	1.38	± 0.84	138
Niacin (mg)	4.06	± 2.03	35^{+}	3.88	± 2.07	33	3.83	± 1.54	33
Vitamin C (mg)	28	± 44	140	33	± 38	165	35	± 26	175

1/ Low income ≤ 1,000 U.S. Dollars/year (79.7% of total population).
Middle income from 1001 to 3,500 U.S. Dollars/year (17.7% of total population).
High income ≥ 3,500 U.S. Dollars/year (3.1% of total population).

2/ Average Nutrient Intake (Flores, 1977).

3/ Standard deviation.

4/ Recommended Nutrient Intake according to the INCAP Nutritional Recommendation tables for the Central American Area (revised, 1973).

Table II. Daily Nutrient Intake and its Percent of Adequacy in the Diet of Honduran Rural Population (person/day), Classified According to Socioeconomic Groups

NUTRIENT	SOCIOECONOMIC GROUP 1/											
	LOW				MIDDLE				HIGH			
	$\overline{X}$ 2/		SD 3/	% RNI 4/	$\overline{X}$		SD	% RNI	$\overline{X}$		SD	% RNI
Calories (units)	1337	±	384	67	1399	±	440	78	2131	±	387	98
Total protein (g)	42.1	±	13.2	83	50.2	±	14.9	94	68.6	±	18.9	118
Calcium (mg)	646	±	310	128	767	±	294	152	1018	±	399	205
Iron (mg)	11.4	±	5.7	90	13.4	±	8.6	104	13.9	±	4.0	97
Retinol equivalents (mg)	152			29	168			29	331			56
Thiamine (mg)	0.72	±	0.26	90	0.83	±	0.29	102	1.02	±	0.33	117
Riboflavin (mg)	0.57	±	0.22	52	0.74	±	0.30	65	1.20	±	0.39	101
Niacin (mg)	7.09	±	2.68	59	8.09	±	2.97	66	11.61	±	3.18	81
Vitamin C (mg)	49	±	61	109	52	±	37	114	90	±	62	183

1/ Low income $\leq$ 1,000 U.S. Dollars/year (79.7% of total population).
Middle income from 1001 to 3,500 U.S. Dollars/year (17.7% of total population).
High income $\geq$ 3,500 U.S. Dollars/year (3.1% of total population).

2/ Average intake using the daily food intake method during three days (Flores, 1977).

3/ Standard deviation.

4/ Recommended nutrient intake according to the INCAP Nutritional Recommendation tables for the Central American Area (revised, 1973).

Table III. Some Food Mixtures Processed by Extrusion at INCAP 1/ 2/

Corn/Soybeans	85/15	82/15	70/30
Rice/Soybeans	82/18	70/30	
Oats/Soybeans	82/18		
Sorghum/Soybeans	70/30		
Cassava/Soybeans	54/36		
Cowpea/Corn + Methionine	65/25	72/28	
Cowpea/Cassava + Methionine	81/19		
Soybean/Sesame	50/50		
Corn/Soybean/Sesame	72/14/14	72/21/7	
Rice/Soybeans/Sesame	72/14/14	72/21/7	
Wheat/Soybean/Sesame	72/14/14	72/21/7	
Corn/Pigeon Peas/Soybeans	60/24/6		
Corn/Redbeans/Pigeon Peas/Soybeans	60/10/10/20		

1/ The Brady is capable of processing a great variety of single and mixed oilseeds, legume grains and cereals. Research was conducted to learn the operating conditions for specific single and mixed foods as well as for the determination of the chemical and biological properties.

2/ Average cost, 1978, in U.S. dollars/100 lbs.: soybeans $12.50; corn $8.10; sorghum $7.00; sesame $20.00; rice $12.89; black beans $19.90.

2. A grant of 250,000 U.S. dollars will probably be obtained from the European Economic Community (EEC) to buy the majority of the processing equipment for the plant.

3. Organizations sponsoring complementary food programs like CARE, CRS/Caritas, WFP and Co-haat (the bi-lateral GOH/German government food for work program) have indicated that they will continue with their programs. However, there is a general consensus (de Muelenaere, Dec. 1978) that within the next 3-5 years more initiative and effort is expected from the Honduran Government (GOH) to help alleviate the malnutrition affecting pre-school and school children.

CURRENT STATUS

The main accomplishment to date on the Maisoy project has been the completion in November 1978 of a detailed feasibility study (PANI, 1978) by a working group with representatives from various local government agencies and INCAP. This study was subsequently evaluated by the director of the Pronutro Research Institute (Durban, South Africa), acting as a special AID consultant to the project, and his observations and findings are being evaluated for incorporation into the final revised form of the study. In fact, at this time INCAP and PANI are working on this revised edition which will be sent shortly to the EEC in order to meet one of the basic requirements to obtain the grant. General information and a summary of the

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Table IV. Results of The Acceptability Trials 1/ with Maisoy

Amount of the sample consumed	Mothers	%	Children	%	Both	%
More than one sample	—	—	1,585	5.7	1,585	4.8
A complete sample	4,915	98.3%	23,277	83.7	28,192	86.0
More than half the sample	37	0.7	724	2.6	761	2.3
Half the sample	4	0.1	543	2.0	547	1.7
Less than half the sample	8	0.2	521	1.9	529	1.6
Refuse to try the sample	35	0.7	1,149	4.1	1,184	3.6
Total	4,999	100%	27,799	100%	32,798	100%

1/ Data obtained from the publication "Truebe Aceptabilidad Mezcla Alimenticia," a report by PANI (National Children's Foundation).

findings and conclusions from the project's feasibility study follow.

Description of the Shareholders

Presently, it is understood that the enterprise will have three shareholders and that administratively it will be run along private industry lines with minimal government interference. The shareholders will be PANI, with a majority of the stock; FANCAP, with 10% of the stock; and a soybean-producing cooperative, with a small percentage. The coop will be included because it is one of the basic requirements placed by the EEC prior to grant approval. However, difficulties are being encountered in finding a suitable coop, because most are poorly organized and not motivated to participate in this kind of project. In spite of this, a coop has been unofficially selected, although no final decision will be taken until a complete survey of possible participants is accomplished. FANCAP, a subsidiary of INCAP, will participate because it is their policy to invest in projects directed to improve the nutritional status of the Central American population. All income from this project will be utilized by them to support applied research or other nutritional development projects in the area. Lastly, it should be recognized that PANI, the institution which initiated the project, has undertaken the major role in the project, because it is one of the state agencies most involved in programs oriented to the general welfare of children--one of the basic objectives of the Maisoy project.

Institutional Markets

The main purpose of the project is to provide Maisoy as a supplementary food to preschool children, school children and to pregnant and nursing mothers. However, since school children are readily accessible and concentrated in larger groups, they will initially constitute the major consumers within the institutional market. Data indicate that in 1978 there were 500,000 school children of which 270,000 were receiving supplementary foods. Nevertheless, due to the generally poor nutritional status of most public school children, it is highly recommended that all school-going children receive the supplementary food. The project aims at expanding the food distribution program by incorporating into the scheme school children not being presently benefited, although this goal will have to be approached gradually owing to technical and economic limitations. For example, assuming the diet of those 230,000 children who did not receive supplementary foods in 1978 were supplemented with 30 grams of Maisoy a day, for 220 school days a year, a total of 1,518 metric tons (M.T.)/annum would be required--a requirement which, according to scheduled plant yearly production of 707, 1,415 and 1,769 M.T. for the

Table V. Percentage of the Total Production of Soybeans That Will Be Required By the Maisoy Plant

Item	1975 1/	1976 3/	1977 3/	1978 3/	1979	1980	1981	1982	1983
Area of cultivation in hectares 1 Hectare = 10,000 M^2)	--	210	454	667	667	887	1079	1473	2134
Metric tons (M.T.) Produced 2/	--	315	681	1000	1000	1330	1618	2210	3200
Plant requirements (M.T.)	--	--	--	--	--	212	424	530	663
Percentage of soy production required by the plant	--	--	--	---	--	15.9	26.2	24.0	20.

1/ Soybean availability is variable since there is no commercial production of soybeans in Honduras. Likely production will be dependent upon land quality, seed, inputs, etc., but might be in the magnitude of 1-to-1.3 tons/hectare. At maximum demand for Maisoy, 1,875 tons of soybeans would require per harvest from 1,400-1,900 hectares. Starting from scratch, this appears to be an unlikely prospect within the next few years, according to an excerpt from USAID/H Maisoy nutrition assessment by Flint (1975).

2/ Source: Soybean production project, Ministry of Natural Resources, Tegucigalpa, Honduras.

3/ Actual production for the particular year.

first, second and third years respectively, could only be met in the third year of operation. Also of interest in this example is that for the 1,518 M.T. needed, the government would have to purchase $834,900 -worth of Maisoy from the plant. Moreover, this amount will have to be increased on a yearly basis because of the steadily-increasing enrollment of school children and higher production costs. Hence, if the goals of the project are to be accomplished, the government has to make a firm commitment to allocate a constant source of funds to purchase Maisoy from the enterprise. It will also be necessary that the GOH and those agencies involved in various food donation programs cooperate more fully so as to eliminate the many existing inefficiencies in the distribution infrastructure.

Supplementation of Maisoy with Vitamins and Minerals

Dietary surveys among rural low-socioeconomic, pre-school children have indicated drastic deficiencies in the daily intake of niacin, retinol and riboflavin. Other deficiencies not as severe, but still of major concern, are inadequate intakes of calories, iron and thiamine. This information, which is quantified in Tables I and VI, was used to calculate the fortification level of nutrients which Maisoy should include. For the calculations it is assumed that a 45-gram sample would be given to the pre-school children, and that total intake for a particular nutrient would be the contribution from his normal daily diet and that offered by the Maisoy sample. Both intakes should roughly add up to 100% of the RNI for the particular nutrient. Vitamin A will not be incorporated into Maisoy because of the recent sugar supplementation scheme at a level of 5000 IU/100 g. Note the high content of vitamin C in the diets (Table I), which is attributed to the very widely-consumed guava (wild fruit).

Retail Markets

The feasibility study has shown that from the sale (in 25-lb. bags) of all production to institutional markets the project can obtain a tangible return of investment from the second year onward (Table VII). Business-wise,

Table VI. Nutritional Contributions Expressed as % RNI [1] For Pre-School Children (ages 4-6) at Proposed [2] Supplementation Levels

Nutrient	RNI	Amount nutrient per 100 grams	Amount nutrient per 45 g.	% RNI obtained from maisoy	% RNI obtained from normal daily diet [3]
Protein (g)	33	16	7.2	22	70
Thiamine (mg)	0.7	0.6	.27	39	57
Riboflavin (mg)	1.0	1.2	.54	54	37
Niacin (mg)	11.6	16	7.2	62	35
Iron (mg)	10.0	10	4.5	45	65

[1] Recommended nutrient intake according to INCAP Nutritional Recommendation tables for the Central American area (revised 1973).

[2] Nutrient content proposed by Dr. de Muelenaere on his consultancy to the project (not approved yet).

[3] Percent of the RNI in the diet of the rural pre-school children belonging to the low socioeconomic group (Dietetic Profiles According to the Socioeconomic Situation in Honduras: M. Flores INCAP 1977).

Maisoy Nutritional Contribution Expressed as % RNI for Pre-School Children (ages 4-6) at Supplementation Levels [1] used in the AID Vitamin and Mineral Pre-mixes

Nutrient	RNI	Amount Nutrient per 100 grams	Amount Nutrient per 45 grams	% RNI obtained from maisoy	% RNI obtained from normal daily diet
Protein (g)	33	16	7.2	22	70
Thiamine (mg)	0.7	0.275	0.124	18	57
Riboflavin (mg)	1.0	0.385	0.173	17	37
Niacin (mg)	11.6	4.95	2.23	19	35
Iron (mg)	10.0	15.4	6.93	69	65

[1] At Supplementation Levels Recommended by USDA for Title II Foods (CSB).

Table VII. Profit and Loss Account 1/

Item	1st Year U.S. Dollars	2nd Year U.S. Dollars	3rd Year U.S. Dollars
Gross sales value 2/	388,850	778,250	972,950
Returns and losses of 1%	3,889	7,782	9,729
Corrected Sales Value	384,961	770,468	963,221
Expenditure			
Production costs	302,462	533,198	672,212
Administration costs	43,313	45,225	46,258
Sales cost	23,243	32,596	37,198
Financing costs	1,875	1,875	1,875
Total expenses	370,893	612,893	757,543
Trading profit 3/	28,138	157,575	205,678
Percent of total investment in plant	2.7	30.8	40.2
Percent of total capital requirement	1.9	21.5	28.0
Percent of sales	3.6	20.2	21.1
Pay back (years)	--	3.1	2.4
Breakeven point in weight sold (M.T.)	680	1,128	1,395
Total production	707	1,415	1,769

1/ Source: Report on Consultancy for Maisoy Food Processing Plant Honduras, de Muelenaere, December 1979.
2/ Maisoy cost to institutions taken as L. 0.50/lb. (L.1.1/kg.) delivered price throughout Honduras.
3/ Maisoy enterprise not subject to company tax for first 10 years of operation.

if such returns were possible they would be highly acceptable. Nevertheless, this scheme is based on yearly allocations from the centralized government, which if not continued due to changes in government or top officials, would place the plant at a standstill or at least in a critical financial position. For this reason, it has been suggested that the enterprise should not be totally dependent on government funding. This could be accomplished by diversifying production and obtaining an income from the retail trade. As of now, it is understood that bulk Maisoy will be sold to institutional markets under the name of Maisoy, but that it should also be sold in the retail market under a different brand name in the form of vanilla-flavored atole, chicken-flavored soup, instant drinks or other similar products. The developmental work for making these products still has to be done; however, expertise in this kind of work is available in institutions like INCAP, and it should therefore be able to be accomplished in a short time and not pose a major problem. Once the formulas are developed and tested, it would be advisable to conduct a feasibility study, somewhat less detailed than the study just concluded for the basic Maisoy formula. Finally, it should be noted that the central government created in 1974 a food retail organization (Banasupro) which, because of its nationwide distribution network of stores, would be the most appropriate to use for test market trials, as well as for one of the distribution networks for subsequent launching of the product in the retail market.

CONCLUSION

The time is ripe for Honduras to start getting some experience in the production of low-cost nutritious foods like Maisoy. Considerable nutritional benefits would be obtainable to those individuals participating in government feeding programs or to those consumers with low purchasing power who desire to purchase a good quality food at a reasonable price. However, the most important benefit from the project would be that the experience accumulated in Honduras would subsequently prove helpful for the design and execution of other nutritionally-oriented schemes. Finally, it should be recalled that the Maisoy project is not just another isolated venture trying to fight malnutrition. It is part of a bigger nutrition program described in the NPFN attempting to reduce malnutrition by an interinstitutional, multidisciplinary and multiprogram approach to the problem. It was previously reported that Honduras has 80% of its population suffering some degree of malnutrition; it is the hope of the NPFN to reduce this to 50% by the year 2000.

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Experience With Extrusion Cookers in India

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I. BACKGROUND AND OBJECTIVES OF SPRA

A. The Soya Production and Research Association (SPRA), which we established in 1971, grew out of our desire

1. To establish a project for the utilization of soyabeans which were being introduced as a farm crop but for which no market seemed to be developing;
2. To develop some soyabean-based food products which could be processed in large quantities and which would be readily accepted by Indian people; and
3. To produce low-cost soyabean-based foods and yet be a viable company which could produce some surplus income for use in developmental and charitable projects.

B. SPRA is a partnership of the Methodist Church in India and the G.B. Pant University of Agriculture and Technology which is the Uttar Pradesh State Agricultural University. It is currently registered as a Partnership and will later be registered as a Charitable Company under Seccion 25 of the Companies Act. Since its inception, SPRA has paid all of its operational costs from its own earnings and shown some net profits for fiscal years 1976-77 and 1977-78. About Rs. 300,000 ($37,500) have been put aside in 1978-79 for training needy young people in technical and vocational trades. These earnings have been from commercial sales through retail stores as well as from sales to government and private agencies for feeding programs and relief operations.

C. The activities of SPRA include nutrition education and trial feedings, agricultural extension (with special emphasis on soyabean cultivation), research and development (for new product development and quality control), engineering (for machinery and parts development), and general rural development. We also have a lab with a food technologist and chemist who are able to conduct a variety of tests for trypsin inhibitor, bacterial count, NSI and many more.

D. SPRA has made it a point not to be dependent on government feeding programs for its economic viability, but rather to restrict these sales to a manageable proportion of its production capacity.

II. EXTRUSION COOKERS AT SPRA

A. There are three extrusion cookers at SPRA. These are a Wenger X-25 with the necessary parts to convert it to an X-900, a Brady crop cooker and a Wenger X-155. (The X-155 is just being brought into production and operates only on a very limited basis at present.)

Most of our experience has been on the X-25 and the X-900. Strictly speaking, only the X-900 and the Brady crop cooker come in the category of low-cost extrusion cookers (LEC's). Yet the experience with the other machines may throw light on the potential and value of LEC's.

B. To operate the X-25 or X-155, it is necessary to grind the raw materials into powder, to have an arrangement to inject water into the barrel of the extruder and to have a drier to reduce the moisture in the finished product. It is also desirable to have a source of steam for pre-conditioning the raw material and also for use in controlling the temperature of the barrel of the extruder.

On the other hand, the X-900 and Brady crop cooker can process unground soyabeans and do not require water, steam or a drier to reduce moisture after processing.

III. OTHER EXTRUSION COOKERS IN INDIA

Several companies now have extrusion cookers in India and are making a variety of products. They are:

A. Karia Cooperative in Gujarat, which has one Wenger X-25 and one or more additional extruders which they constructed by copying the X-25. This organization appears to be producing a weaning food for commercial sales as well as product for certain government feeding programs.

B. Mysore Snack Foods Company of Bangalore has a X-25 and is producing product for government feeding programs. They attempted to produce TVP for the commercial market but withdrew after a few months.

C. Unichem Company in Ghaziabad, U.P., has an Anderson extruder but does not appear to have a product on the market yet or to be producing for government feeding programs.

D. Two small companies, one in Bombay and one in Delhi, have extruders and are producing snack foods for commercial sales.

E. An ex-employee of SPRA has made a modified copy of the X-25 which is in operation in Indore and is producing TVP.

We understand that the Modi Industries are planning a large extrusion cooking facility with Wenger equipment. SPRA is also planning an addition of two Wenger X-175 cookers shortly.

While extrusion cooking in India is still in its infancy, it is now well established as a potential major food processing technique.

IV. TYPES OF PRODUCTS PRODUCED BY SPRA ON VARIOUS MACHINES

A. Commercial Products

Textured vegetable protein This is produced on the X-25 and the X-155. It is packaged in 250-gram and 100-gram packages for sale through retail stores and in 20-kg. bags for sale at reduced prices to institutions.

Corn-defatted soya weaning food This is produced on the X-25 but probably could be produced on the X-155 also. It is packed in 500-gram packages for commercial sales.

Rice-defatted soya snack food flavored with peanut oil and local spices This product is made on the X-25. It probably cannot be made on the X-155 with the configurations available with us at present. This is packed in 50-gram and 19-gram high density polyethylene (HDP) bags for commercial sales and in 10-kg high density polyethylene bags for institutions.

B. Feeding Program Products

Corn and ground soyabeans This mixture was made on the X-25 with variations tried on the X-900 configuration and the Brady crop cooker. The runs on the X-900 and Brady were not satisfactory.

Ground cereal grains Plain rice, wheat or corn are gelatinized on the X-25. These could be run on the X-155 with the right configuration and possibly on the X-900 and Brady crop cooker. However, rice might pose a greater problem on these two machines than wheat or corn.

Full-fat soya meal from whole ground soyabeans This had been produced on the X-25 and can be produced on the X-155. The use of steam and/or water during or prior to extrusion and drying after extrusion seem to increase the rate of processing. Due to problems of feeding the ground material into the X-900 configuration and into the Brady crop cooker, we have not used them for this product. Possibly a coarse grind would overcome the feeding problem in the X-900 and Brady.

Full-fat soya meal from whole unground soyabeans This product is run on both the X-900 and Brady.

Full-fat soya meal from dehulled soyabeans This product is run on both the X-900 and Brady.

These items are supplied to feeding programs and institutional kitchens as is or mixed together in various combinations with sugar.

We feel that full-fat soya flour and a combination of full-fat, wheat and sugar have good commercial prospects as a product for low-income families. We feel that more nutritional benefits can be derived from the availability of low-cost nutritious foods for home use than through government-sponsored feeding programs--although both approaches are necessary.

Our inability to put the full-fat soya flour and a cereal/full-fat soya product on the market commercially is due to our inability to find suitable packaging material at a low enough cost. Neither of the two "obvious" materials, LDP nor HDP, is suitable. Due to the oil content, even 400-gauge (4-mil) LDP becomes sticky, and

HDP starts splitting within a few weeks. There are suitable materials, but they cost as much or more than the ingredient being packed.

V. GENERAL OBSERVATIONS

The following general observations based on our experience of the past seven years appear to be valid:

A. The best gruel powder and the cereal grain is made when the soyabeans are extruded by themselves, then ground and mixed together with the required flavoring, vitamins and minerals. This was also the most economical way of producing these gruels.

When soyabean and cereal grains are combined before extruding, the rate of processing tends to be that of the cereal grain, which is much slower than that of soybeans alone. Using a 50-hp motor on the X-25, cereal grains extrude at the rate of about 4 tons/24 hours. With a 50-hp motor on the X-900 configuration, whole unground soyabean extrudes at a rate of about 10.5 tons/24 hours.

Thus to produce 85 tons of product takes 510 hours extrusion time with the cereal grain and soyabean combined, and only 357.6 hours if they are extruded separately. Eighty-five tons of extruded product are sufficient to make 100 tons of gruel using the formula of 44% cereal, 41% full-fat soyabean, 14.5% sugar and 0.5% vitamins and minerals.

We have produced the above product very satisfactorily using either the Brady crop cooker or the X-900 to extrude the soyabean and the X-25 to extrude the cereal grain. In 1978 we sold this to the U.P. Government for a price of Rs. 2.75/kg (@ Rs. 8.10 = $1.00, this comes to $.34/kg). Twenty-five kgs of product were packed in 400-gauge (4-mil) HDP liners inside HDP woven bags.

B. A satisfactory processing alternative to the gruel powder described above is to extrude only the soyabean and then process the cereal grain in some other manner. Two possibilities are parboiling and roasting. The final quality and uniformity of the products depend on the quality of these processes.

In India there is a caste of grain parchers in the villages who traditionally parch and puff various grains using hot sand. During 1978 we employed this method to roast about 70 tons of wheat for the above formulation. The cost of roasting was approximately the same as extrusion cooking.

While this product was satisfactory when used within a three-month period, it was not so good or stable as the product made from extruded wheat. Its shortcomings were:

1. There was considerable variation in the amount of roasting between batches.
2. There were more chances of contamination. However, the product remained within the limits of the bacterial content allowed by the specifications.
3. The shelf life appeared to be less and the problem of insect contamination was greater. However, we were not able to fully establish whether this was due more to the form of processing or to the change in seasons from hot and dry to hot and humid during the time the order was being produced.

C. When raw soybean whether full-fat or defatted and cereal grains are combined before extrusion, it is possible that the inactivation of the trypsin inhibitor is not to the desired degree. We have found there is more trypsin inhibitor present in a given quantity of a snack food using 14% defatted soy with an original NSI of 54% than in the same amount of textured vegetable protein which is made 100% from this same defatted, or than in extruded full-fat made from whole raw soyabeans.

If the trypsin inhibitor in the soya flour is not properly inactivated and only 10 to 15% is used in a product, there will not be enough trypsin inhibitor to cause problems. However, in a product using 41% soyabean the trypsin inhibitor could be significant, especially when the product is fed in rather large amounts to small children.

VI. THE BRADY CROP COOKER AND THE WENGER X-900

A. The Brady crop cooker

The Brady came to us through CARE and G.B. Pant University after it had been used by a firm in Calcutta. The screw was completely worn out and the feeding mechanism was corroded and out of order.

The Brady has one rather shallow screw which is the full length of the barrel. The feed is by a hydraulic-operated auger. To open the Brady for cleaning is a rather complicated and time-consuming process.

After repair and reconditioning, we powered the Brady first with a 50-hp motor and then with a 40-hp motor through herringbone gears. We have now replaced the gears with pulley and V-belts.

The Brady worked well with both power drive arrangements and with both sizes of motors. For comparison purposes we will consider only the performance with the 50-hp motor.

It is easy to operate, stabilizes rather quickly and runs smoothly when processing whole soyabeans into a full-fat product.

B. The X-900

The X-900, like the Brady, was intended to be used for cooking whole soyabeans on the farm run from a tractor power take-off. However, our X-900 is a modified configuration of screws, heads and feeding mechanism which fit the X-25 housing and base and uses the same power source. It takes about two hours to convert from the X-25 to the X-900 configuration.

The barrel of the X-900 is made up of several deep flight screws, each about 8" long, and the same number of heads which fit together over them. This results in easier cleaning and dismantling of the extruder as compared with the Brady. The feeding is done from a hopper through a syntron which drops the beans into an opening in the barrel. The X-900 takes longer to heat up and stabilize than the Brady. This is probably due to the greater mass of the barrel of the X-900.

The X-900 is somewhat more difficult to start up, but it also runs very smoothly in processing whole soyabeans into full-fat granules. For certain products we find these granules do not have to be further ground.

C. Comparisons of cost

The purchase price of the X-900 is substantially more than for the Brady. We also found the screws on the X-900 wear faster than on the Brady. The rebuilding of the X-900 screws and heads requires more skill than for the Brady.

The output of the X-900 was about 430 kg/hr of full-fat product and of the Brady about 280 kg/hr. In both cases a 50-hp motor 1/ was used, and about 60 tons of whole soyabeans were run on the Brady in about two months. More than 100 tons were run on the X-900 at various times over the past three years.

Production costs, not counting the initial cost of the machine or overheads, have come to about U.S. $22.50/metric ton ($0.0225 or Rs. 0.18 per kg) on the X-900 and U.S. $32.70/metric ton ($0.0327 or Rs. 0.262 per kg) on the Brady.

D. Advantages of each machine

The X-900

high production per hour
lower cost of production
easier cleaning
more versatile
inactivation of trypsin inhibitor good (0.05 when measured as urease activity)

The Brady crop cooker

lower initial cost
easier to operate
less skill required for maintenance
inactivation of trypsin inhibitor good (0.10 when measured as urease activity)

VII. BASIC REQUIREMENTS FOR PRODUCTION FACILITIES HOUSING A LEC

A. Equipment

Grain cleaning is essential and can be done by hand or mechanically. Cleaning by hand methods proved very satisfactory for us. However, as hand-cleaning

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1/ Production on the Brady while using the 40-hp motor was 230 kg/hr. This came to 5.75 kg of full-fat per 1-hp. With the 50-hp motor we got 5.60 kg of full-fat per 1-hp.

was done by women, we found the various government regulations regarding employment of women impossible for us to comply with and have had to install machinery.

We have had to use both graders (scalping) and spiral cleaners to do an adequate job. If material is to be ground and mixed before extrusion, it will be necessary to have a hammer mill, paddle mixer and a scale.

Transportation of the raw material from this section to the LEC can be by conveyor or manually in bags.

The processing unit will include one or more LECs, a hammer mill for cooked product, a paddle mixer for cooked product and a scale. If cereal grain is to be machine-roasted, this equipment could also be included here. A compressor or some sort of blower is very helpful for cleaning up the machines.

If village roasting is to be done, this should be away from this section, probably in a shed nearby.

In areas where electricity is not reliable (large voltage fluctuations and frequent power interruptions), the LEC should be run directly off a diesel engine. A power interruption of about 2 seconds will cause the LEC to jam up and can require as much as 2- or 2½-hours' clean-up time.

A complete maintanance shop will require a heavy duty lathe with grinding attachment, a flexible shaft grinder, a bench grinder, a pedestal drill, arc welding equipment, blacksmithy equipment, a shaper, hand tools and electrical testing and repair tools.

If a reliable machine shop is available very close by, the lathe and shaper can be eliminated, but most of the other equipment will be necessary.

B. Buildings

The production building or room should be rat-proof, bird-proof and screened against flies. It should contain only the LECs, milling equipment, mixer for processed or cooked materials, and bagging and closing equipment (if in packings of 20 kg or more).

The floor should be of some smooth material which is easy to clean and sloped so that it may be washed. There should be an adequate drain(s) along the sides or down the middle of the floor.

If unprocessed soyabeans or cereal grains are to be ground and mixed before processing, this must be done either in a different building or in a room completely closed off from the production room. The milling and mixing equipment used for this must not be used for milling and mixing processed food.

Cleaning of the grains (either mechanical or by hand) can be done in this area but preferably should be done in a separate place of its own.

Packaging, if in small units of less than 20 kg, should be done in an area isolated from the production unit. This area should provide space for storing of any unpacked processed goods and another space for packed goods. (No material should be stored or kept in the production area.)

Stores include grains for processing, packaging materials and spares. A proper system of stores with adequate storage space is essential. It will probably be necessary to purchase materials in rather large quantities in order to insure supplies. We have to purchase the whole year's soyabean supply in a two-to-three month period, packaging materials in two-weeks-to-two-months' requirements at a time, and several units of certain spares have to be kept in stock at all times.

Unless adequate maintenance facilities are available nearby, it will be necessary to have a fairly large room for maintenance to house a lathe and other equipment for making spares and assembling equipment. Blacksmithy facilities are necessary. Blacksmithy can be undertaken in an open shed or outdoors.

Due to the dust and noise of the factory it is desirable that office space be partitioned off. The factory site will need to be enclosed by a wall. In many places a separate water supply will be required. Some lab testing facilities would be ideal and helpful.

VII. CONCLUSION

At SPRA we feel that LEC's can fulfill an important need in providing low-cost nutritious foods for both the commercial market and for feeding programs in many Third World countries.

The choice between the Brady Cooker and the X-900 will depend upon the conditions under which the project is carried out and what one expects the future of the project to be.

Anyone attempting a project with a LEC will have to be very determined and show a great deal of initiative and imagination in establishing and implementing the project.

The LEC Program in Indonesia

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I. BACKGROUND

Institut Pertanian Bogor (IPB--its English name is Bogor Agricultural University) is one of the agricultural universities in Indonesia and consists of 18 departments. The three-fold aim of the higher education program of IPB is education, research and extension. The goal of IPB, generally speaking, is to develop and to modernize the agriculture of Indonesia by providing well-trained specialists to conduct research and extension activities applying current knowledge of science and technology. This goal supports the national goal for agriculture, i.e., "to develop an integrated effort to increase production, equalize income distribution and create more employment opportunities for the agricultural sector."

Nutritional problems in Indonesia still exist. They are, mainly, (1) protein and calorie malnutrition; (2) vitamin A deficiency; (3) goitre; and (4) nutritional anemia. These are dominantly affected by the availability and supply of food-crop production in the country. During the Second Five-Year Development Plan period, (1973-1978), the government has successfully increased the agricultural food-crop production, especially rice and corn (Table I). However, because the population has also increased, and owing to other socioeconomic and political factors, the government had to import rice in the amount of 2.5 million tons in 1977. Soybean production in 1977 was only 0.5 million tons, and it was imported from foreign countries in the amount of 0.75 million tons to meet consumption needs.

IPB is involved in action research and extension programs to combat nutritional problems. Its Rural Sociology Research Institute has been implementing a community nutrition program whose goal is to find the effective methods of informal education and extension to improve effectively the nutritional status of the rural poor inhabitants. This is a pilot project which implements the results of the 1973 evaluation study on the Applied Nutrition Program, sponsored by UNICEF/FAO/WHO. This pilot project has been underway since 1976 and will be terminated at the end of 1979. The area of the project covered 5 Kabupatens 1/ (3 in West Java and one in Central Java). The pilot project is managed by the Institute and supported by four departments in IPB, i.e., the Department of Rural Sociology and Agricultural Economics; the Department of Home Economics and Food Science Nutrition; the Department of Agronomy; and the Department of Agricultural Engineering.

IPB and the Cooperative for American Relief Everywhere Inc. (CARE) have worked together in developing certain supplemental foods of high nutrient value and in the testing of Brady products since April 1976. Through this cooperation, IPB has been able to involve itself in LEC technology and has thus contributed to the justification for the use of such a technology in the nutritional intervention program in Indonesia.

II. TRAINING AND TESTING PROGAAM

Training in Indonesia was held in August 1976. It took about two weeks, and the instructor was Mr. Ronald E. Tribelhorn, from CSU. The trainees were two participants from IPB, two from Plantation No. XII , Ltd., Co., (a government-controlled estate) and one from CARE-West Java.

The testing facilities consisted of the Brady crop cooker, type 206, powered by a 100-h.p. Caterpillar diesel engine, model 3304 N.A. Power was transmitted directly by a coupling, and the speed of rotation was reduced by a model T-18-12 speed reducer. To grind the materials the "Bisley Mill" was used. This is a swinging-type of hammer mill, in which, with the finest screen, the whole grain can be ground into relatively fine material (-20, +50). This machine is powered by its own engine diesel of 18 h.p.

Mixing was done manually, using boxes. Three boxes of about three tons each and three boxes with holding capacity of about 0.75 tons were used. The materials were mixed by shovels.

1/ Roughly the same as a U.S. county.

Table I. Rice and Corn Production

A. Population, Rice Production and Imported Rice in Indonesia, 1970-1977 1/

Year	Population (X million)	Rice Production (X million) Tons	Rice Consumption (X million) Tons	Imported Rice (X 1000 tons)
1970	—	13,140	—	763,481
1971	120,149	13,742	—	541,154
1972	123,115	13,505	—	1,229,537
1973	126,068	14,445	—	1,229,005
1974	129,083	15,275	15,079	1,147,512
1975	132,110	15,185	15,682	667,386
1976	135,190	15,845	16,308	1,505,873
1977	138,500	15,900 2/	16,961	2,400,000

1/ Soekarto, S.T. and F. G. Winarno (1978). The Appropriate Technology in the Diversification of the Indonesian Menu. Paper presented at the National Workshop on Food and Nutrition. July 10-14, 1978, Bogor.
2/ Prediction.

B. Corn production in Indonesia, 1972 - 1976 1/

Year	Production (metric tons)
1972	2,254,382.00
1973	3,689,802.00
1974	3,010,781.00
1975	2,902,887.00
1976	2,551,779.00

1/ Winoto Martoadiprawiro (1978). The Utilization of Corn for Human Food in Indonesia. Ibid.

C. The utilization of corn in Indonesia, 1972 1/

Utilization	Total	Percent (%)
Food consumption	1,825,740.00	81.70
Feed consumption	211,876.00	9.40
Export	79,646.00	3.50
Seed	127,722.00	5.00
Loss	9,016.00	0.40

1/ Winoto Martoadiprawiro (1978). op.cit.

A water application kit supplied water from the 800-l. tanks (4 drums, connected to each other, of 200-l.) placed 2.5 meters above the hopper of the extruder. In this way, water just dropped by gravity.

Weighing was done using a 500-kg platform balance, and there were also provided plastic bags of about 50-kg capacity.

During the training several mixtures of cereals and legumes were processed. On the last day of the training period, people from various institutions were invited to view a demonstration of the extruder operation. Several expressed interest, including the Director of the Plantation No. XII, Ltd., Co., and the head of the Food and Nutrition Bureau, Ministry of Agriculture.

VII. IMPLEMENTATION OF THE PROGRAM

A. Developing Local Mixtures

Rice, corn and cassava are the main sources of calories in the food consumption pattern in Indonesia. Therefore, the mixtures of rice (70%) + soybean (30%); rice polish (70%) + soybean (30%); corn (70%) + soybean (30%); and cassava (70%) + soybean (30%) were studied.

All mixtures were easy to extrude, except that with the rice polish and soybean mixture the temperature of extrusion did not reach 300°F (an average was only 260-270°F). Table II shows the conditions of extrusion. All materials were produced locally: ORBA soybean variety, HYV-rice variety and local cassava variety (unidentified).

Proximate analyses were done by the Nutrition Research Development Center, Ministry of Health, and the results indicated that the protein content of the cassava and soybean mixture is low, as expected, but that the three others are more than 16 per cent. All of the mixtures have an energy content of nearly 400 calories per 100 grams (Table III).

The rice polish (70%) and soybean (30%) mixture was chosen by the Nutrition Intervention Program of IPB for its supplemental food program to implement the study of informal-education-plus approach. Plantation No. XII, Ltd., Co., used the mixture of corn (70%) and soybean (30%) for its food supplement program, thus continuing the program started in 1973/74 with assistance by CARE.

Before those mixes were used they were subjected to taste testing and acceptability tests. Three mixtures, No's 1, 3, and 4 (Table II) were tested as to their acceptability by people at the plantations. CARE conducted this test at three locations in the rubber and tea plantation areas, and the results showed that all mixes were accepted. Testing of the mixture of rice polish (70%) and soybean (30%) was conducted by the Department of Home Economics and Food Nutrition. The test was only taste testing, and the result indicated that the mixture was a little bit bitter, depending on the freshness of the rice polish (a sample prepared from fresh rice polish tasted good).

B. The Use of Supplemental Food

1. Rice polish (70%) and soybean (30%)

This mixture, needed by the Nutrition Intervention Program of IPB, is only a small amount, i.e., only 9-10 metric tons per year. But this year this project will use about 12 tons of mixture.

Important results of this study are: (1) the mixture is fairly acceptable; (2) the cost is very low (U.S. 20 cents per kg), and--most important--(3) people realized that the mixture is nourishing and can improve their health. Almost all of them said that they want to buy such a mixture if it becomes available--an indication that there is a potential market.

Calculations made for a future program (enlarging it to become a nationwide food supplement program) indicate that the installation of a LEC extruder (in this case, a Brady crop cooker, Model 206), complete with pre-and post-extruding facilities for processing a blended food, is feasible; it can serve an area of 8-9 Kabupatens, or almost one province (on the basis of 1,000-1,100 metric tons output per year). And it was also stated that such an installation has the potential to support the national food supplement program.

2. Corn (70%) and soybean (30%)

To continue the food supplement program, the Plantation No. XII, Ltd., Co., used the Brady installa-

Table II. The Conditions of Extrusion of Local Mixtures

Mixtures	Control valve (scale)	Cone clearance (Rotations)	Water addition (scale)	Extruder temperature (^oF)	Capacity kg./min.
Rice 70%, soybean 30%	2.5	2-3	1.0	300	7.3
Rice polish 70%, soybean 30%	2.0	2	0	260	7.0
Corn 70%, soybean 30%	2.5	2	0	325	7.7
Cassava 70%, soybean 30%	2	2	0	290	7.4

Table III. Proximate Analyses of Local Mixtures

Mixtures	Nutrient content (proximate) %					
	Water	Ash	Protein	Fat	Carbohydrate	Cal/100 g
Rice 70%, soybean 30%	6.6	2.4	16.6	7.2	67.2	400
Rice polish 70%, soybean 30%	6.8	2.9	16.8	7.2	66.8	398
Corn 70%, soybean 30%	6.2	2.6	17.0	9.5	64.7	412
Cassava 70%, scybean 30%	7.4	3.2	13.0	8.1	68.3	408

tion to process their material. In the fourth quarter of 1976 they processed 45 metric tons and in 1977, 180 metric tons (85 metric tons were a 70% sorghum and 30% soybean blended food); the corn and sorghum were provided through CARE by the AID Food for Peace program.

In 1978 they processed corn (70%) and soybean (30%) blended food in the amount of 185 metric tons. The corn used was local corn (dent corn, HARAPAN variety), but the soybeans purchased from the local market were called "Americana" and were imported from Brazil. This year, 1979, they plan to process the same amount of corn and soybean blended food.

The recipients of the food are laborers and their families--about ten thousand people. The quantity of blended food distributed to them freely is not fully based on nutritional needs; rather, it is based on the director's willingness to increase the laborers' wages, since the government regulates wages at a very low rate (about one U.S. dollar per day only). However, observations indicated that the recipients accepted the corn and soybean blended food, and the program is termed a success by the director.

IV. PROBLEMS AND FUTURE POSSIBILITIES

It can be seen that LEC technology--especially its contribution to the nutrition program--is in the beginning stage. The next stage is to extend the technology so that the decision-makers (Government of Indonesia) decide to use it in the national nutrition program.

All possible events were used to promote LEC technology. The seminar on food technology, held June 21-23, 1977, provided time to discuss the potential use of blended foods (rice, corn and soybean blends), with the result that such a blended food was suggested for use in the Nutritional Intervention Program. On July 10-14, 1978, the appropriateness of low-cost extrusion cooking technology was also discussed as one of the topics of the National Workshop on Food and Nutrition (held by the National Institute of Sciences, LIPI) where it was termed an appropriate technology to encourage the diversification of the Indonesian menu. The third event was that of the seminar on extruder-cookers held on October 23-24, 1978, by the National Institute of Chemistry (part of the National Institute of Sciences, LIPI) to extend the potential use of extruders as versatile, simple and hygienic equipment for food processing, and to discuss the potential of the Brady crop cooker in the Nutrition Intervention Program.

One institution which was interested in creating a program to manufacture blended food was the PUSPETA (Farmers' Service Center - a cooperative federation of 35 KUD's in Kabupaten Klaten, Central Java), an entity developed by the Cooperative League of the USA (CLUSA) in order to assist the Directorate General of Cooperatives, Ministry of Commerce of the GOI, to strengthen cooperative institutions in Indonesia. Discussions between CLUSA, CARE and IPB were conducted, and a definite program was initiated and has been developing. It is similar to the manufacturing of Thriposha in Sri Lanka--a step-by-step process towards self-reliance in the implementation of their program.

Of special interest in planning the program was the utilization of rice polish, since the PUSPETA had a good, big-scale rice mill capable of two tons of polished rice output per hour. With CARE still providing the Brady installation at IPB, and working together with CLUSA, testing was done of 8 mixtures consisting of 15-50% rice polish. One of the mixtures consisted of dehulled soybean (25%), cassava flour (20%), whole wheat (10%), rice polish (30%), brown sugar (12%) and salt (0.2%) for a total of 97.2 percent. The balance of 2.8% was allotted to vitamins, minerals and flavor, which were not available during testing. The mixture was found to be very easy to extrude; it used more locally-produced materials; and it was expected to have the best baking quality. It was planned for blending with CSB and WSB to have two kinds of mixtures: (1) "Local Mixture" (40%), CSB (50%) and WSB (10%); and (2) "Local Mixture" (40%), CSB (40%) and WSB (20%). The mixture would be manufactured during the first year of the program (the time span is 5 years to reach a self-supported status). This program needs not only hard effort to make it well planned and successful, but also support from the government and other international institutions.

ACKNOWLEDGMENT

Some progress with and successful implementation of LEC technology has been experienced in Indonesia, and the technology is spreading wider and wider. This is the time when IPB would like to express its thanks to its partners, especially CARE and CLUSA, for their cooperation and support. Many thanks also are due to CSU and USDA-AID for inviting me to this Second International LEC Workshop.

The Wonseong County, Korea Project

Dr. Walter J. Bray
Meals For Millions Foundation
Santa Monica, California

During the first twenty years of its existence the Meals For Millions Foundation was involved only with the distribution of Multi-Purpose Food (MPF), a protein-vitamin-mineral enriched powder food base. By the late 1960's, however, it was realized that MPF and other foods handed out free to the needy were not in fact helping to reduce malnutrition nor improving the lot of the poor in the developing countries.

A search for solutions to a wider range of food and nutrition problems led the Foundation to consider ready-to-eat foods, i.e., foods which could be made locally from indigenous raw materials and tailored to the needs and tastes of the consumers. This interest led in turn to a consideration of extrusion cooking.

In the early part of this decade existing extruders presented a number of problems: capital costs were high, operation was frequently unstable and many machines did not produce food-grade products in the desired variety of forms and shapes. Thus by 1974 Meals For Millions had initiated work on an extruder of its own.

A grant from U.S. AID in the following year made possible comprehensive design and development work, and a prototype unit was ready by 1976. This machine and its later improvements are described in the paper by H. Sterner.

At this time the Foundation was active in Korea and Ecuador and was planning to use extrusion cooking in projects in both countries. The potential for this type of cooking seemed particularly high in Ecuador, since the use of soy to enrich foods was a logical extension of an existing project to teach farmers to raise soybeans.

An extruded mixture of soy and rice was developed as the base for a strawberry-flavored drink. This was to be sold in the city of Guayaquil, and special efforts were to be made to reach the poorer children. Unfortunately, the Foundation was not able to obtain either the cooperation of the local government or the support of a commercial group in this undertaking and was obliged to terminate the project in mid-1977.

Meanwhile, plans were developing for a project in Korea. It was now decided to produce and market highly-nutritious low-cost extruded foods, starting with snack foods and progressing to weaning foods and powdered food bases. These activities were to be focussed on Wonseong County, a rural area about 100 km east of the capital, with a specific target of nutritionally at-risk groups, such as infants, young children, pregnant and lactating women--about 10,000 people in all.

The main objective of the project was to find ways to induce the poorer at-risk members of the community to purchase and consume highly-nutritious foods. Other objectives included:

1. Determining whether the manufacture and sale of these foods could be the basis of a viable business;
2. Deciding whether the routine consumption of highly-nutritious foods would improve nutritional status; and
3. Evaluating the MFM/KIST extruder in a production situation.

The Wonseong County Project was from the very beginning a joint effort involving Meals For Millions, the Korean Institute of Science and Technology (KIST), ASI, a leading market research firm, nutritionists from Korea University and the Korean Government.

I will explain this project and its current status by reviewing the work done by each of these groups.

KIST built the extruder and also developed an operating procedure for it. They then went on to develop the basic product formula and studied ways of improving product acceptability.

Nutritionists led by Dr. Ju of Korea University conducted several surveys in Wonseong County to establish the need for specific nutrients and to provide baseline data which would permit measuring the impact of the highly-nutritious foods and the concurrent nutrition education program. This survey included food intake, anthropomorphic measurements of the children and the collection of socio-economic data. It established the need for iron, calcium, vitamin A, riboflavin and ascorbic acid, and hence supplied the nutritional specification for the product.

Market research carried out by ASI identified snack foods as a particularly promising means of introducing highly nutritious foods and also showed the desirability of selling the snacks in individual serving-size bags containing 20 or 40 grams each. ASI also did product evaluation studies and acceptability tests.

The Government of Korea, working through the local county authorities, has provided land and buildings for the food manufacturing plant and has also agreed to subsidize the product with an annual grant of $65,000.

In order to raise the nutritional status of the local population the county will distribute HN foods to 1,000 of the poorest residents. In addition, the local government has assumed joint responsibility with Meals For Millions for a comprehensive nutrition education program. This means that MFM nutritionists, supported by a substantial grant from U.S.A.I.D./Korea, are training county social workers, teachers and members of the local army reserve, who in turn are educating the local population. The program is designed to promote awareness of nutritional needs, with special emphasis on HN foods, and is regarded as an essential component of the overall project.

Concurrently with the above nutrition education program and the coordination of the work of the participating groups, MFM is setting up a non-profit-making company to produce and market HN foods and will provide this company with technical and managerial assistance through 1982, when the project is scheduled to end.

The process used to produce the HN foods is outlined in the flow chart, Figure 1. Meals For Millions has bought the required equipment in the U.S. and Korea, and it is now being installed. The number of staff needed to operate the plant is quite small, as can be seen from the organizational chart, Figure 2.

The basic product formula is shown in Table I. Note that other flavoring ingredients, such as peanut or cheese, may replace the sesame in order to give variety. Either salt or sugar can be applied to the surface of the snacks in order to improve acceptability.

Table I. Composition of Snack Food Products

Corn	68.0%
Defatted soy flour	20.0%
Sesame	2.0%
Oil	4.0%
Salt	1.0%
Sugar	4.0%
Antioxidant	200 mg/Kg
Calcium	3.75g/Kg
Iron	200 mg/Kg
Vitamin A	22,200 IU/Kg
Vitamin C	665 mg/Kg
Riboflavin	10.5 mg/Kg
(Protein Content	Approx.18%)
(Caloric Content	3650 Kcal/Kg)

The raw material cost of the snackfoods is detailed in Table II, while Table III presents a general breakdown of the estimated selling cost. Thanks to the government subsidy for the project, the breakeven price for the entire operation is expected to be $ 0.07 for a 40-gram bag. The product will be sold to the local shopkeepers at this price, and they in turn will retail them at $0.083 a bag, a price which is equal to or lower than that of most of the currently available snackfoods. As sales increase above the figure projected for the first year of operation, costs will naturally decline, and the business can be expected to develop to the point at which it will be viable without the subsidy.

Production and test-marketing of snack products is expected to start in March. Marketing will be expanded as rapidly as possible so as to cover the entire county by mid-year and to include institutions by the year's end. As soon as is practical, additional products will be developed to meet the demand for weaning foods and other types of HN foods.

Experience gained in the next four years in the Wonseong County Project will make it

Table II. Product Raw Material Cost 1/

Material	Cost	Product Cost*
Corn	$0.318/kg	$0.2220
Soy	0.688	0.1437
Sesame	5.167	0.1079
Oil	1.833	0.0766
Sugar	1.042	0.0435
Salt	0.171	0.0018
V+M	3.125	0.0327
Bags	0.008 ea	0.2105
Boxes	0.260 ea	0.0664
		$0.09053/kg

1/ Basis: 1.0 kg product.
*Includes 4.5% losses.

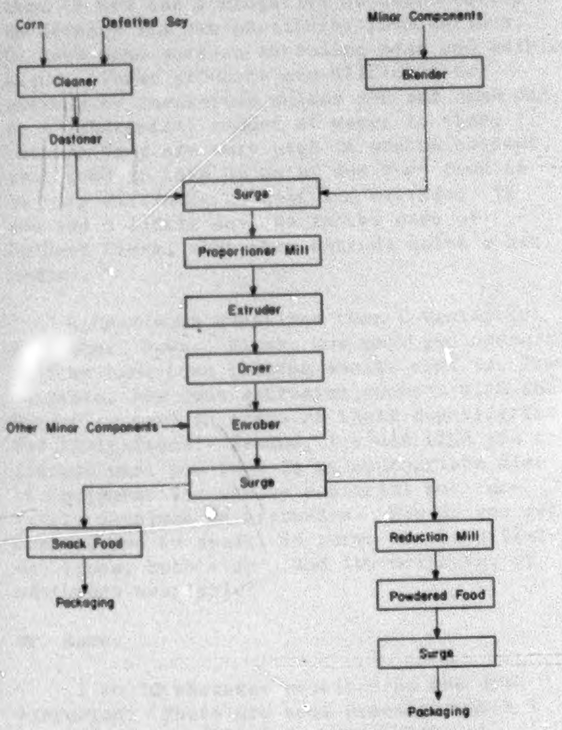
Corn
Defatted Soy
Minor Components
Cleaner
Blender
Destoner
Surge
Proportioner Mill
Extruder
Dryer
Other Minor Components
Enrober
Surge
Snack Food
Reduction Mill
Packaging
Powdered Food
Surge
Packaging

Figure 1. Flow chart for the production of HN/LC foods.

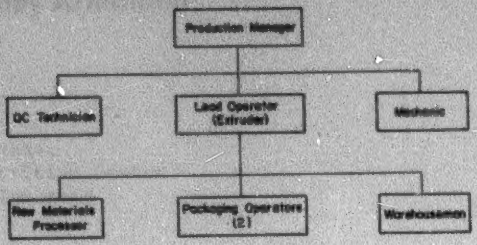
Production Manager
QC Technician
Lead Operator (Extruder)
Mechanic
Raw Materials Processor
Packaging Operators (2)
Warehouseman

Figure 2. Organizational chart.

possible for MFM and the Government of Korea to decide if the non-profit company should continue production and marketing on a permanent basis. Assuming that the work is successful, MFM will probably also seek to start similar projects in other countries. It is not expected, however, to embark on other programs involving extrusion cooking before 1982.

In the meantime, MFM hopes to keep in close touch with other groups working with low-cost extrusion and to share with them the information obtained in Korea.

Table III. Product Selling Cost

	Per Kg	Per 40-g bag
Raw Materials	$0.9053	$0.0362
Mfg expenses	0.5047	0.0202
Administrative expenses	0.3476	0.0139
Sales expenses	0.3450	0.0138
VAT/10%/	0.2083	0.0083
	$2.3109	$0.0924

Discussion - Tuesday Afternoon

Moderator:

Mr. Hamis Lukoo
Tanzania Food and Nutrition Center
Dar es Salaam, Tanzania

Mr. Sterner:

In the evaluation of the Brady crop cooker by Colorado State University to find out the abilities of the machine, have there been any studies to compare conventional methods of making instant soup and other similar foods with the extrusion method?

Dr. Harper:

We have done a variety of testing to determine the capabilities and limitations of all these low-cost extruders, but we have done very little work dealing with specific product applications. In our testing we have primarily looked at what ingredients could be extruded under what sets of conditions, how well they were cooked and these sorts of things. We paid little attention to how they would be used in processes, because USDA felt that it was the prerogative of each country to develop its own particular formulations. We have done work on extruding peas and edible beans. These products are difficult to extrude by themselves unless you add some oil or a substantial amount of water to them, because they are very high in starch content, they tend to take up water and they tend to be very difficult to heat and extrude. If you add a little soy, as in the case of Delbert Clark, then they extrude quite a bit easier.

I have some questions that I wanted to ask Robert Nave. First, how would you compare what we have been talking about, that is, low-moisture, low-cost extrusion cookers with the Wenger systems in terms of their capabilities and limitations? Second, I would like you to discuss what you feel is an appropriate size of equipment for use by countries not currently involved in extrusion. How do you get started, so to speak, in terms of the different types, both high- and low-moisture, of extruders available?

Mr. Nave:

I would wherever possible do the dry extrusion. There are some products which I am sure won't work on dry extrusion--at least as much as we know about them now--so we will have to use alternative methods.

Dr. Harper:

Can you give us some examples?

Mr. Nave:

One in particular is textured vegetable protein. I think as far as possible you ought to keep things simple, but all of these we have seen are fairly complicated. The only way I can see to eventually get a simple system is to work with only one kind of product--say full-fat soy flour--and do it on such a small scale that all of the production could be utilized within a very small area. If you could get something that would work on a 10-h.p. motor and all of the production from it could be used within a 5-10 mile radius of the place where you produced it, then we really would have something spectacular.

At least in India, almost every major state will have somebody with a diesel engine or an electrical motor, and they will have a rice dehusker, a small flour mill and possibly even a sugar cane presser, all of which they attach according to the demand and the season.

If we could make a small, easy-to-clean extrusion cooker that could also be plugged into that whole system at the time when the people want to get their beans cooked, they could then try to produce the full-fat soy flour for baby foods and for general use in the home kitchen, as well as for animal feeds. I think you would really have something then. It would have to be something that could tolerate the power failures I mentioned. We have lots of them, and when you get into the villages, even more. You have to have something that you can open very, very easily. The Wenger idea on the bigger machine of a split barrel may be the direction which extruder design should pursue.

Dr. Harper:

What equipment is appropriate for people starting in this business?

Mr. Nave:

I think most countries should stick to whatever is available and should buy the equipment that has proven itself. I think the sizes we are talking about here--your 900, the Insta-Pro and the Brady--are all right in terms of size and production. This one they are using in Korea may also be all right. I think we know enough about extrusion cooking now that we need to evaluate each situation before coming up with an answer. I don't think any of us knew much about extrusion in 1971, and we made a provision for every eventuality--which increased our costs tremendously in setting up. For our X-25, we have five different shops, all with different possibilities, because we didn't know which would go. Now we could cut it down to two shops and maybe even one. You need to evaluate what you are doing and to think in terms of what the potential market is. In India, for example, we have so many millions--in our state along there are 100 million--that we must think a little bit differently.

Dr. Harper:

I was attempting in my paper yesterday to look at some of the relative economic factors such as operating costs and capital costs. You can say that wet extrusion systems basically have more flexibility but that they have higher initial capital costs and have more operating parameters compared to the low-cost system--it is a relative thing.

Mr. Nave:

If you want flexibility, then the Wenger/Insta-Pro system meshing together gives you tremendous flexibility--probably, in fact, the maximum flexibility. The larger Wenger machines are not so flexible as the X-25, and if you know exactly what products you want to make, you might be better off with a series of that size than with a series of bigger machines. This is the thing you have to evaluate.

Dr. Harper:

I came to that same conclusion, and I was just wondering if you agreed. Could you talk briefly about costs versus operating costs with these extruders? My analysis showed that there are significant differences in capital requirements, but that if you bought large-scale equipment and used it well, then the capital costs wouldn't make that much difference. Of course, if somebody is starting out without knowing the size of the market or what he is doing, and he buys a very large, complex extruder which is not used to the fullest extent, he has a real capital nightmare. So I felt there was good reason to start relatively simple and small to gain that experience. Then perhaps as products and markets developed, there would be a chance to re-evaluate some of those inital assumptions.

Mr. Nave:

I think that if you are going into a relatively full-scale production and you have a pretty good idea of how to go, then your capital costs are really not your main problem--aside from getting that loan or whatever is involved in raising the capital. In terms of total cost, it is not your major problem--it is your operating costs, wastage, poor maintenance and lack of managerial skills. These are the places where you run into cost problems--not because you had to spend a few hundred thousand to begin with. In terms of the amount of production you have, it's a relatively small amount. But you're dealing with such large quantitites of expensive commodities which can depreciate so badly.

We've had the experience of buying up stuff and then running into some sort of management or technical problem; we had a pile of grain sitting there, too big to put inside our housing, the monsoon came, and we had a loss. This is the kind of thing that causes you problems. Or, it didn't work out quite the way you wanted, so you ended up with a lot of rat and insect infestation. These are much more serious cost problems than your initial investment.

Mr. Crowley:

Perhaps it should be made clear that the costs of systems vary a great deal with capacity. If you put in a large extruder system in a factory to manufacture foods, say you want an output of about 10,000 tons, it would require a capital investment of something like a million dollars, whereas if you want to have an output of 1,000 tons per year, the investment is something like $100,000. And to have a large plant operating at 10% of capacity puts just an enormous burden on your product.

Mr. Nave:

I was assuming that that part was already accepted. Yes, you've got to have your margin, you've got to know what you're trying to do. Once you're doing it, it isn't a capital problem. If you have much too big a plant for what you need, then you've got lots of problems. Your plant should be bigger than your ability to sell your products.

We find that for every shift we operate, we get about a 40% decrease in our overhead. So running three shifts is a whale of a lot cheaper than running two or one. And our production tends to go up. When we're running three shifts, and everything is running the way it is supposed to, we don't close down for 6 days. There's no start-up and close-down, and we save a tremendous amount of material that way. I would prefer to take a plant and run it 2 days, three shifts, and then keep it closed the rest of the time, because you would save so much more material. There are labor laws which make that almost impossible to do, at least in India.

Mr. Crowley:

But again, the primary point from the standpoint of the U.S. government's interests in these small extruders is that there are many situations where you don't have the need for production of very large amounts, and you don't have a population of a hundred million to whom you distribute the products.

Mr. Nave:

Let me say that the more I hear and experience, the more I think that something running on about 10 h.p. would be a much better thing to develop--twenty maximum, but ten more ideally. We really ought to get in and help the people at the village level.

Mr. Bleyer:

I have the problem that people are not accustomed to eating these foods, no matter how attractive or cheap they are. Who will help then grow accustomed? Who will go to the people to teach them to use these foods? I want to sell the food, but you leave it at the store, then you go again and they haven't sold it--you have that kind of a problem.

Mr. Nave:

The first year that we produced we had difficulty selling the three tons of product for almost nine months, and we delivered packages--2 packages, 4 packages and 6 packages here and there. We tried to give away textured vegetable protein and the people wouldn't take it, so we know what you're talking about. We re-evaluated the whole thing, and we said that first you have to gain a certain amount of prestige for your product and the concept--and here I'm talking primarily about textured vegetable protein, because it was an absolutely new thing. You know, if you make a new biscuit or something like that, everyone knows how to eat it, but nobody knew how to use textured vegetable protein, because that was a completely new concept. Finally we went to the biggest store in Delhi, in the most important place, we enlisted a friend of the proprietor, and we forced him to take our product--he just couldn't say "no" to his friend. Then we persuaded him to give us some of his store space, and we put our people there to demonstrate the uses of textured vegetable protein. Then we proceeded from there to other stores. We tried to find stores where there was a women's club or some sort of a cooperative organization where people got together, and we got one or two good men to give demonstrations and to sell the product at that point and then say we were going to put it in such-and-such store. This way, we got a very slow growth, and we got up to about 20-to-25 tons a month, and then we sort of moved from there. At that time we were packaging in plastic bags--we used both high- and low-density bags--but the product punctured holes in it, and it looked bad after a while. Then we went to a paper box around the plastic bag, and that improved it some. Then about 2 years ago, we went to another system, that of a laminated bag inside a box. It was a little more expensive, and as soon as we got better packaging, business and sales just got completely out of control. We had no advertising budget. This was done by the Methodist Church. There were no recipes available; the first recipes were developed by my wife and me in our kitchen. We wrote them up, and these are what were used for the demonstrations. It's not an easy process, but it is possible. And if you're talking about a population of 5,000,000, and you're working with a Wenger, you're going to have to make several different products; otherwise, you won't be using it to its full capacity and it will be very expensive.

Dr. Nichols:

When you improved the package, did you find that you had to change the price? You did raise the price. By what percentage of retail would you say it went up because of the package change?

Mr. Nave:

I suppose that the increase we made was about 10%--you wouldn't have had to make it quite that much, but there were other factors involved. I suppose that two or three per cent was the direct result of the package change.

Dr. Nichols:

But you're saying that you increased the price, and the package was changed, and sales went up?

Mr. Nave:

Yes.

The LEC Program in Korea

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INTRODUCTION

Extrusion cooking is now practiced widely in the production of snack foods, blended foods, textured vegetable protein and inactivation of enzymes (Crowley, 1976). The Korean Institute of Science and Technology (KIST) has had several years of experience in the development of a high-nutrition low-cost (HNLC) food utilizing barley-soybean-sesame (BSS) and corn-soybean-sesame (CSS) compositions through the extrusion process. KIST also has fabricated a low-cost food extruder which was originally designed by Meals for Millions Foundation (MFM), U.S.A., in relation to Wonseong County Comprehensive Nutrition Program in Korea (Cheigh et al., 1978). KIST operated the MFM-KIST extruder for test production of HNLC food products and had some experience in the intensive research and development of low-cost extrustion cooker (LEC) systems. Additionally, experimental trials on the pre-cooking of cereal for the pasta product using the MFM-KIST extruder were conducted in cooperation with the technical staffs of the Instituto de Investigaciones Technológicas (IIT), Colombia, at KIST. Also, trials on the stabilization of rice bran were performed with both the MFM-KIST extruder and a Bonnot Laboratory extruder which was installed at KIST.

THE WONSEONG COUNTY COMPREHENSIVE NUTRITION PROGRAM IN KOREA

South Korea, over which the Republic of Korea now exercises jurisdiction, is 98,477 square kilometers in area, which represents 43 per cent of the whole area of the Korean peninsula. Agrarian land in South Korea is some 20 per cent of the total area. The population of 36 million lives mainly on cereal grains such as rice and barley. Per capita daily supply of the total calories, protein and fat has steadily increased in the past years. Although the 1976 supply of calories and protein in Korea was not comparable to the level of advanced western countries, in Asia it was on the upper level at least quantitatively. Koreans rely on vegetable sources for the supply of nutrients, that is, 94 per cent of calories and 83 per cent of protein, and this necessitates qualitative improvement of Korean diets (MAF-Korea/FAO-Korea, 1977).

The Wonseong County Comprehensive Nutrition Program started as a field demonstration in 1976 to overcome this nutritional problem. The goal of the Wonseong County Project, supported by Korean local government and MFM, is to assist Wonseong County, Gangwon Province of Korea, in promoting better physical and mental health of 10,000 preschool children and expectant and nursing women. This was to be accomplished by experimenting with and manufacturing a product of high nutrition at a low cost, using local raw materials.

As an essential portion of the Wonseong County Project, KIST had a responsibility to provide food technological inputs to the formulation and production system of HNLC foods.

THE MFM-KIST EXTRUDER

MFM and KIST adapted a low-cost extrusion cooker (LEC) system for the production of HNLC foods for the Wonseong County project. MFM provided a draft design of the extruder, and KIST modified it and prepared a detailed design for its fabrication, which was done at the KIST machine shop. The MFM-KIST extruder is designed mainly for gelatinizing starch and expanding cereals. It is a 1½-inch single-screw unit, and the screw has constant pitch. It is driven by a 30-Hp motor whose speed can be changed with a 3-speed gear box. The barrel is divided into three sections without any cooling or heating jackets. The inner faces of the barrel have four ribs that run parallel to the longitudinal axis of the barrel. The MFM-KIST extruder is capable of producing up to 100kg of product per hour. Detailed specifications of the machine are shown in Table I.

Any cereal could be used as a raw material, if it has a moisture content of around 13 per cent as a minimum. The material is fed to the extruder through a feeding system with variable speed. The water can be injected into the

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1/ Dr. Cheigh was unable to attend the workshop but submitted his paper for inclusion in these proceedings.

material in the extruder barrel. The wet, heated material mass passes through the die, where it gets extruded and expanded (Cheigh et al., 1978).

The MFM-KIST extruder is mechanically simple and easy to operate and maintain (Anon, 1977). The extruded product could be used as a snack food or as a porridge base after milling.

DEVELOPMENT OF HIGH-NUTRITION LOW-COST (HNLC) FOOD WITH A LEC SYSTEM FOR THE WONSEONG COUNTY PROGRAM

Preliminary formulation of HNLC foods for the Wonseong County project was made on the basis of barley-soybean-sesame composition (BSS) and corn-soybean-sesame composition (CSS). The barley has been a popular grain in the Korean diet for a long time and is produced as the second largest crop in Korea. Barley and corn were considered as a source of energy in BSS and CSS composition. The soybean is the only crop in Korea which can raise protein content and improve protein quality of barley or corn after mixing. Addition of sesame as a source of methionine and tryptophan would correct to some extent the deficiency of these two amino acids in CSS and BSS composition. (Sesame is an acceptable food ingredient to the Korean.) The level of protein content in the formula ranged from 17 to 21 per cent and the product is expected to provide 330 to 373 Cal per 100g. And special consideration of fortification with vitamins and minerals was also given to the formulas.

Trials for the test production of proposed formulas using the MFM-KIST extruder are summarized in Table II. Products from formula CSS-1, CSS-3 and BSS-4 were acceptable in terms of machine performance and product quality.

Proximate composition, mineral and vitamin values of the products are shown in Table III. Protein contents of the products are around 18 per cent, and they have reasonable contents of minerals and vitamins. The amino acid composition of the product is shown in Table IV. It was considered that the contents of lysine in formulas CSS-3 and BSS-4 were relatively higher than corn or barley alone. In animal feeding experimentation, protein efficiency ratios (PER's) of the proposed formulas are given in Table V. In general, PER's for the products were significantly higher than that for barley only. PER values suggested that the proposed product should be adequate in protein quality for feeding the target group in Wonseong County.

Table VI shows the results of sensory evaluations by scoring differences for flavor, taste, texture and color of BS-1, BSS-4, CSS-1 and CSS-3 formulas. Generally, the CSS formulas showed better scores than the BS or BSS formulas in flavor, taste and texture. However, there were no significant differences between CSS formulas. Also, BS-1 was not significantly different from BSS-4. All products had similar taste and aroma, and cooked soybean taste was found as aftertaste. Trials for organoleptic quality improvement and storage stability tests were conducted, and then minor modification was done for each formula (Cheigh et. al., 1978).

PARTIAL COOKING OF RICE AND CORN FOR A PASTA PRODUCT WITH THE MFM-KIST EXTRUDER

In general, pasta products are produced from durum semolina. In some countries where durum wheat is not locally grown, common wheat semolina is usually used for pasta products. IIT of Colombia has considerable experience in the formulation of pasta production with composite flour. The research results of IIT indicate that rice, corn and soybean hold good promise for partial substitution of wheat semolina in pasta production. However, rice and corn must be partially pre-cooked before use as a substitute for wheat semolina. The main concept of IIT's research is to adapt the extrusion technology for the pre-cooking of rice and corn and to use the extrusion cooker for the unified pasta production process.

Two technical teams of IIT visited KIST and participated in feasibility studies of utilizing the MFM-KIST extruder for the pre-cooking of rice and corn. Twenty-kg samples of yellow corn, regular corn and rice flour extruded at about 50°, 68° and 80°C were produced and evaluated by measuring the dextrose index and viscoamylography for the determination of degree of modification.

Results show a proper degree of modification, as the dextrose index values are lower than 50 and the viscosity values of extruded materials are lower than those of the raw materials. It was considered that the characteristics of partially-cooked flours could be suitable for pasta production.

The samples of pre-cooked cereals were ground to pass 60-mesh and mixed with defatted soy flour and wheat semolina in the proportions of 50 per cent pre-cooked cereal, 25 per cent soy and 25 per cent wheat semolina. The mixes were kneaded and the resulting dough was extruded to obtain spaghetti-type pastas. The behavior of the mixes during the dough preparation and pasta extrusion operation was very good, especially in the case of rice. The cooking characteristics of the final pasta products made of regular wheat semolina and composite flours showed that the pasta obtained from extrusion-cooked products is rather similar to regular wheat semolina pasta. These results show that the MFM-KIST extruder is versatile enough to produce low degrees of pre-cooking and that the extruded products have acceptable characteristics for their use in composite flour pastas (De Buckle et al., 1978).

EXPERIMENTS ON RICE BRAN STABILIZATION BY THE EXTRUSION PROCESS

Rice bran, a by-product of rice milling, contains about 18 per cent lipids and yields about 16-17 per cent oil when fresh bran is extracted. During the storage of bran, however, the lipids in the bran are rapidly hydrolyzed by lipase which is present in the bran. This hydrolysis results in poor extraction rate of oil and poor quality of the product.

It is expected that the extrusion process could be used to inactivate the lipase and to modify the physical properties of the rice bran so as to minimize the problems encountered in the solvent extraction of oil.

Rice bran was extruded with the two types of extruders--the Bonnot and MFM-KIST extruders--according to given conditions as shown in Table VII. This shows differences due to extruder, temperature and retention time. When treated at temperatures higher than 130° C and without addition of water, the residual peroxidase activity was less than 23 per cent of the initial activity. We know that high moisture levels (over 20 per cent) in bran are essential for the treatment of enzyme inactivation; however, we were looking for any possibility for the inactivation without wet treatment before extrusion.

The stabilized rice bran was stored in cotton cloth bags under conditions of 30°C and 87 per cent relative humidity for 5 weeks. Figure 1 shows free fatty acid changes in raw and extruded bran during storage. The effect of extrusion on free fatty acid development in bran is significant. These results suggest that the MFM-KIST extruder could be used in stablization of rice bran, but at the same time they demonstrate the need for modification of the prototype design which can be economically attached to the local rice mills (Cheigh and Kim, 1978).

FUTURE PROGRAM

KIST has had several years of experience in the technology of cooking extruder systems, and we have observed that the MFM-KIST extruder has much potential to process the HNLC foods from a variety of ingredients, to modify the characteristics of cereal for pasta products and to stabilize the rice bran-lipase.

Future programs utilizing extruders at KIST are briofly outlined as follows:

1. KIST extruder fabrication

   We are developing a KIST-designed and fabricated extruder, which is a relatively simple one with high capacity, for local food producers. This extruder is being developed for the manufacture of high-nutrition (and high-cost) snack-type foods. We expect the extruder to be commercially available by the end of 1979.

2. Development of an extrusion process and a low-cost extruder for rice bran stabilization

   We have a three-year (1978-1980) research project on the development and utilization of the extrusion process and low-cost extruders for rice bran-oil stabilization at the site of local mills. As stated above, extrusion technology could be used to inactivate the lipase and to modify the physical properties of the rice bran so as to minimize the problems encountered in the solvent extraction of oil. The purpose of this project is to improve the utilization efficiency of rice bran, which is the most abundant potential source of oil in Korea, through (1) development of techniques for stabilization of rice bran by the extrusion process, and (2) development of a low-cost extruder which can be economically attached to the local rice mills.

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Crowley, P.R.: "Extrusion Cooking as a Utilizable Technology to Produce Nutritious Foods," International Workshop Proceedings, Fort Collins CO (1976).

De Buckle, T.S. et al.: IIT Progress Report on "Design and Construction of a Prototype of an Extrusion Cooker for Use in an Unified Pasta Production Process" (1978).

Ministry of Agriculture and Fisheries-Korea and FAO Korean Association: Food Balance Sheet (1977).

Table I. Specification of MFM-KIST Extruder

Main motor	:	1,750rpm, 22KW, 30HP
Feeder motor	:	1,710rpm, 1.5KW, 2HP
Supply power	:	at 220V, 3phase, 60HZ
Variable drive	:	(1) 1:11.5 ratio (2) 1:6.5 ratio (3) 1:4.0 ratio
Screw shaft speed	:	(1) 150rpm (2) 273rpm (3) 430rpm
Diameter of screw	:	2½ inch
Maximum production capacity rated	:	80-100kg/hr
Length	:	200cm
Width	:	200cm
Height	:	190cm

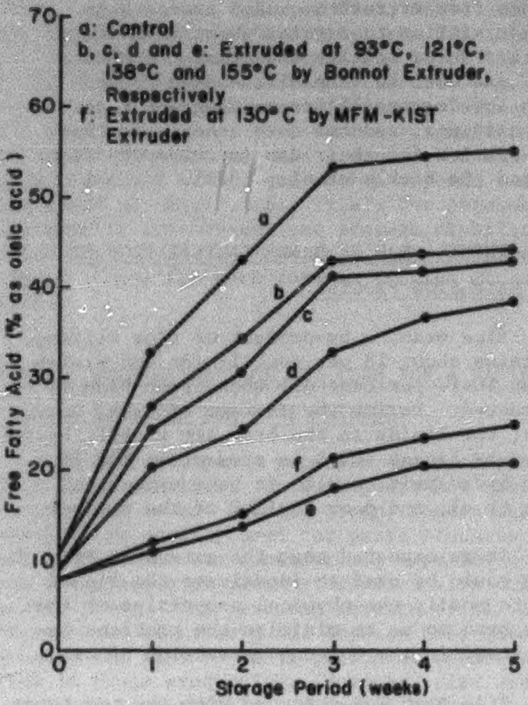


Figure 1. Effect of extrusion temperature on free fatty acid development in rice bran during storage at 30° C and 87% humidity.

Table II. Trials for Test Production of Proposed Formulas with MFM-KIST Extruder

Formula	Composition(%)*	Machine Performance	Product Quality
BS-1	Barley (70) Defatted soy (28) Other (2)	Smooth	Slightly expanded Good flavor
BSS-1	Barley (72) Full-fat soy (18) Sesame (2) Others (8)	Fluctuating load	Small flakes Beany flavor
BSS-2	Barley (56) Defatted soy (28) Sesame (2) Others (14)	Not smooth	Well expanded Good flavor
BSS-3	Barley (63) Full-fat soy (27) Sesame (2) Others (8)	Not smooth	Small flakes Beany flavor

Table II. Trials for Test Production of Proposed Formulas with MFM-KIST Extruder (continued)

Formula	Composition(%)*	Machine Performance	Product Quality
BSS-4	Barley (65) Defatted soy (25) Sesame (2) Others (8)	Smooth	Well expanded Good flavor
CSS-1	Corn (55) Defatted soy (29) Sesame (2) Others (14)	Smooth	Well expanded Good flavor
CSS-2	Corn (63) Full-Fat soy (27) Sesame (2) Others (8)	Fluctuating load	Small flakes Beany flavor
CSS-3	Corn (65) Defatted soy (25) Sesame (2) Others (8)	Smooth	Well expanded Good flavor

*Others include corn oil, sucrose, vitamin and mineral.

Table III. Chemical Composition of Proposed Products

	CSS-3	BSS-4
Moisture (%)	6.18	6.68
Carbohydrate (%)	68.76	67.9
Protein (%)	17.99	18.32
Fat (%)	2.74	2.89
Ash (%)	4.33	4.21
Ca (mg/100 g)	332.5	348
Fe (mg/100 g)	4.7	5.75
V-A (IU/g)	53	30
V-B_1 (μg/g)	1.7	1.7
V-B_2 (μg/g)	6.2	5.1
Niacin (μg/g)	85	49

Table IV. Amino Acid Composition of Proposed Formulas

(unit: %)

Amino acid	CSS-3	BSS-4
Lysine	0.941	0.879
Histidine	0.478	0.431
Arginine	1.050	1.064
Aspartic acid	1.723	1.978
Threonine	0.785	0.757
Serine	1.062	0.995
Glutamic acid	3.979	4.318
Proline	1.206	1.670
Glycine	0.773	0.822
Alanine	1.083	0.902
Cysteine*	-	-
Valine	0.809	0.887
Methionine	0.240	0.235
Isoleucine	0.707	0.762
Lucine	1.721	1.531
Tyrosine	0.534	0.663
Phenylalanine	0.912	1.041

*Cysteine, cystine and hydroxyproline were not determined precisely.

Table V. Protein Efficiency Ratio (PER) of Proposed Products

Products	Weight gain* (g)	PER	Adjusted PER**
Barley only	52.4	2.18±0.17***	1.51
CSS-1	59.8	3.37±0.10	2.33
CSS-3	59.2	3.41±0.11	2.36
CSS-4	62.1	3.64±0.10	2.53

* 14 days weight gain
** PER x 2.5/PER for casein
*** Mean ± Standard error

Table VI. Results of Sensory Evaluation Of Products*

	BS-1	BSS-4	CSS-1	CSS-3
Flavor	3.6	3.7	2.9	3.0
Taste	3.8	3.3	2.4	2.6
Texture	3.6	3.4	2.6	2.4
Color	4.3	3.9	2.8	2.1

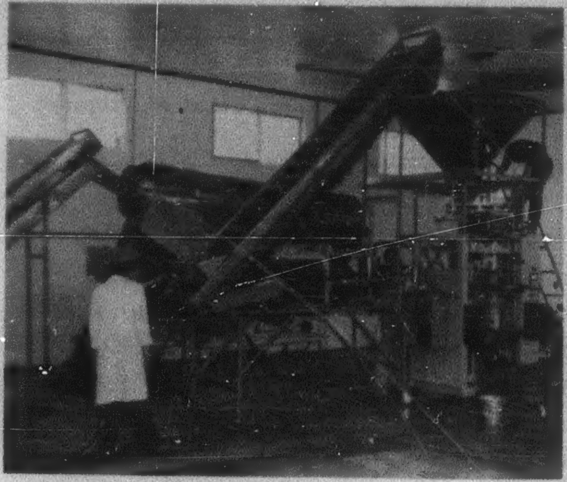
*Scoring was based on a 6-point system (excellent: 1 point; very bad: 6 points), and the score of products bound with a line means there is no significant difference between them at the 1-percent level.

Table VII. Effect of Extrusion Temperature and Retention Time on Moisture Content and Residual Peroxidase Activity of Extruded Rice Bran

Treatment*			
Equipment-Temp (C)	Time(sec)	Moisture(%)	Residual** Activity(%)
Control	-	11.1	100
B-121	18	9.2	45.1
B-138	14	8.5	23.1
B-155	18	7.0	3.1
MK-130	18	8.1	20.8

* 1. Without moisture addition
2. B : Bonnot-Laboratory extruder
MK: MFM-KIST extruder
3. Temperature at the end of barrel.

**Peroxidase activity.



Dryer, enrober and packaging machine at KIST.

Nutritional Aspects of the LEC Program at Colorado State University

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From a nutritional perspective, the Low-Cost Extrusion Cooker (LEC) Program at Colorado State University has two major components. These are: (1) nutritional evaluation of extruded products, and (2) nutritional specifications for extruded products.

The overall objective of the LEC program is to use a relatively simple technology and indigenous food crops to provide low-cost nutritious foods, and to introduce the resulting foods into child or maternal feeding programs with the intention of achieving a nutritional impact. This impact includes reducing the mortality and morbidity and increasing the growth and well-being of pre-school children.

Since the first conference at Colorado State University several years ago, our work has emphasized corn/soy blend and full-fat soy flour, since these represent the major food products currently being extruded at a number of production sites around the world. In this paper, some of the nutritional evaluation work we have carried out on corn/soy blend and full-fat soy flour will be presented, along with the results of several studies with cereal/cottonseed blends. Then, the nutritional specifications for Title II blended foods will be reviewed in the light of current nutritional knowledge and from the perspective of the LEC program. Finally, product evaluation services available at Colorado State University will be outlined.

I. NUTRITIONAL EVALUATION OF LEC FOODS

A. Pre-clinical Evaluation of CSB

Corn/soy blend (CSB) has been an accepted blended food distributed under PL 480 for a number of years. According to guidelines for clinical testing of supplemental foods intended for feeding pre-school children established by the Protein-Calorie Advisory Group (PAG) of the United Nations, CSB made on a low-cost extrusion cooker (LEC) would not require clinical testing beyond tolerance and acceptability testing. However, even though only animal testing would be sufficient, we desired to have CSB made on a LEC receive a thorough clinical evaluation, since it is the basic blended food currently being made at a number of LEC sites around the world.

Three samples of CSB (70% corn, 30% soy) were made using a Brady extruder #206 at 163°C. These blends were: (1) degermed corn and dehulled soy, (2) whole corn and dehulled soy, and (3) whole corn and whole soy. All blends were fortified after extrusion with 0.1% vitamin and antioxidant premix and 2.7% mineral premix as specified by the USDA for Title II blended foods. The results of the pre-clinical evaluation will be presented in this paper. These samples were then sent to Dr. George Graham for clinical evaluation in his metabolic unit in Peru. The final report of Dr. Graham's evaluation is not yet available.

Proximate analysis data for the three blends are summarized in Table I. All met Title II specifications for protein and fat, and only the whole corn/whole soy blend exceeded the specification of 2.0% fiber. One of the significant nutritional advantages of using whole corn is the additional fat, but this has to be balanced against the increased fiber level. These issues will be addressed later in this paper.

The results of a four-week rat growth evaluation are summarized in Table II. Confirming earlier work, all three blends resulted in protein efficiency ratios (PER's) equal to or better than that of reference casein. The exceptionally-high corrected PER of 2.91 obtained with the whole corn/dehulled soy blend is likely to be a result of increased palatability as well as a somewhat improved amino acid pattern. However, the differences in quality seen in Table II are of no real consequence for human nutrition. They all at least are equal to casein in protein quality for the rat. The protein values of these blends for pre-school children will relate more to differences in digestibility in the child than to amino acid composition *per se*. The pre-clinical evaluation would suggest that from a protein quality standpoint, all three products should be satisfactory for feeding human populations including children. Although all products are well below the PAG specification of 5.0% fiber for supplemental foods, it is not yet clear how much and what type of fiber would be acceptable for feeding young children. Until this point is clarified, it will be desirable to dehull both the corn and the soybeans for blended foods intended to be used as

Table I. Chemical Analysis of Corn/Soy Blends 1/

Properties	Degermed corn dehulled soy	Whole corn dehulled soy	Whole corn whole soy
Moisture - %	2.8	3.3	3.6
Fat - %	6.8	9.2	8.6
Protein - % 2/	17.0	18.6	17.8
Ash - %	4.2	5.1	5.1
Fiber - %	0.8	1.9	2.3
Carbohydrate - % 3/	68.4	61.9	62.6
Nitrogen Solubility - %	4.8	6.4	6.7

1/ All blends corn/soy (70/30) extruded at 163°C with Brady.
2/ N x 6.25.
3/ By difference.

Table II. Rat Growth Evaluation of Corn/Soy Blends (4 weeks' growth)

Sample Description	Weight gain (g)	PER 1/	Corrected PER 2/
Degermed corn/dehulled soy 70/30, 163°C Brady	129.9 ± 6.4 3/	3.02 ± .06	2.63 ± .05
Whole corn/dehulled soy, 70/30, 163°C Brady	150.1 ± 3.6	3.34 ± .06	2.91 ± .05
Whole corn/whole soy 70/30, 163°C Brady	137.5 ± 5.6	3.04 ± .08	2.46 ± .07
ANRC Casein	111.4 ± 4.2	2.88 ± .09	2.50

1/ Protein efficiency ratio equals weight gain (g) / protein consumed (g).
2/ Corrected relative to Casein = 2.50.
3/ Mean ± Standard Error.

weaning foods. Addition of dry milk to extruded corn/soy blends will improve the protein value of the final product, although such addition does not appear to be necessary from a nutritional standpoint.

B. Evaluation of Cottonseed and Chickpea Blends

Several experiments were carried out to explore the capability of a LEC to produce blended foods from cereal-cottonseed blends. In the first experiment, blends of corn with glanded cottonseed and sorghum with glandless cottonseed were extruded at two temperatures on a Brady #206 extruder. The cereals were whole grain, and both cottonseed samples were delinted and dehulled. Total and free gossypol levels were determined by official AOCS procedures, and a rat growth evaluation was carried out on all blends.

As shown in Table III, free gossypol levels of the corn-glanded cottonseed blends were reduced to 0.03-0.05%. Free gossypol levels in the glandless cottonseed flour or blends were below the limits of detection of the method. Corrected PER's for all blends were in the range 1.5-1.9, considerably below that of casein. Increased extrusion temperature lowered the PER, especially in the case of the corn-glanded cottonseed blend, undoubtedly because of an increased loss of lysine during processing.

The PER for glandless cottonseed was equal to that of casein (Table III). Extrusion of glanded cottonseed reduced the free gossypol level only from 0.63% to 0.21%. However, weight gain was increased from -16.9g to 79.3g, and the PER of the extruded glanded cottonseed flour was a respectable 1.89±0.07. A free gossypol level of 0.21% is considerably above the PAG specification of 0.06% for cottonseed flour. Experiments are planned in which reduction of free gossypol by addition of iron salts, as reported previously by Bressani and colleagues at INCAP, will be evaluated.

The lysine deficiency in the blended food made from corn and glanded cottonseed extruded at 170°C is clearly shown by the data in Table IV in which the PER was increased from 1.73 to 2.54 by addition of L-lysine monohydrochloride.

In a second experiment, full-fat glanded cottonseed flour and corn-glanded cottonseed blends were extruded on a Brady #206 extruder and an Insta-Pro #500 extruder. The results are presented in Table V. At the same temperature, the cottonseed flour extruded on the Insta-Pro gave a somewhat lower weight gain and PER. In contrast, the weight gain and PER of the cereal-cottonseed blend were both higher with the Insta-Pro, but unfortunately the extrusion temperatures differed in this experiment. The meaning of these relatively small differences in PER's is not clear at the present time, since optimum extrusion conditions for the two machines for protein quality have not yet been worked out.

Cereal-chickpea blends (1:1) were extruded on the Brady and blended after extrusion with 10% non-fat dry milk (based on final weight of the blend). The results of a rat growth evaluation of blends based on wheat, sorghum and rice are presented in Table VI. All three blends gave corrected PER's at least as good as casein, with the blend based on rice giving a corrected PER of 2.94, compared to casein at 2.50.

C. Full-Fat Soy Flour

Another important food product that can be made on an extruder is full-fat soy flour. Indeed, the Brady and Insta-Pro extruders were originally developed to extrude soybeans for use in animal feeding.

Whole and dehulled soybeans were extruded at 138°C on the Brady and at 143°C in the Insta-Pro extruder. Following extrusion, the resulting products were ground into full-fat soy flours. Trypsin inhibitor and urease activities were determined on these flours and a rat growth evaluation was carried out. The results are shown in Table VII. The higher extrusion temperature on the Insta-Pro increased the destruction of anti-trypsin activity and significantly increased PER's for both whole and dehulled soybeans. Urease activity appears to be more easily destroyed and to be a less-adequate indicator of the effectiveness of heat treatment of soy than anti-trypsin activity or rat growth evaluation.

The effect of the addition of water prior to extrusion on the destruction of anti-trypsin activity was evaluated, and the results are summarized in Table VIII. The addition of 3% water to whole soybeans increased the destruction of anti-trypsin activity from 30.6 to 53.7% With this amount of water added to dehulled soybeans, destruction was increased from 39.1% to 67.8%.

To clarify the temperature needed for effective heat treatment of soybeans, an experiment was carried out on the Brady in which dehulled soybeans were extruded at temperatures ranging from 121°C to 149°C. The extruded products were ground into flours and evaluated for: (1) proximate analysis, (2) anti-trypsin activity, (3) urease activity, (4) PER, and (5) nitrogen

Table III. Rat Growth Evaluation of Cereal-Cottonseed Blends 1/ (4 weeks' growth)

Sample Description	Total gossypol (%)	Free gossypol (%)	Weight gain (g)	PER 2/	Corrected PER 3/
Whole corn/glanded cottonseed (70/30) extruded together (170°C)	0.26	0.03	57.9±4.9 4/	1.92±0.11	1.52±0.09
Whole corn/glanded cottonseed (70/30) extruded together (142°C)	0.26	0.05	79.1±4.6	2.41±0.05	1.90±0.04
Whole sorghum/glandless cottonseed (70/30) extruded together (170°C)	< 0.01	< 0.01	73.2±3.6	2.22±0.05	1.75±0.04
Whole sorghum/glandless cottonseed (70/30) extruded together (142°C)	< 0.01	< 0.01	77.9±5.2	2.37±0.07	1.87±0.06
Glanded cottonseed, extruded	0.83	0.21	79.3±6.7	2.39±0.09	1.89±0.07
Glanded cottonseed, raw	0.86	0.65	-16.9±1.6	-0.90±0.13	-
Glandless cottonseed, raw	0.09	0.03	136.2±4.0	3.15±0.05	2.49±0.04
ANRC Casein	-	-	119.0±4.8	3.16±0.09	2.50

1/ Extruded with Brady.
2/ Protein Efficiency Ratio (PER) = weight gain (g) / protein consumed (g)
3/ Corrected relative to an assigned value for ANRC Casein of 2.50.
4/ Mean ± Standard Error.

Table IV. Effect of Lysine Fortification on Extruded Corn/Glanded Cottonseed Blend 1/ (4 weeks' growth)

Sample Description	Weight gain (g)	PER 2/	Corrected PER 3/
Whole corn/glanded cottonseed 70/30 extruded together 170°C	50.4±3.8 4/	1.73±0.09	1.51±0.08
Whole corn/glanded cottonseed 70/30 extruded together 170°C + 0.5% L-lysine monohydrochloride 5/	94.9±4.8	2.54±0.07	2.21±0.06
ANRC Casein	111.4±4.2	2.88±0.09	2.50

1/ Extruded with Brady.
2/ Protein Efficiency Ratio (PER) = weight gain (g) / protein consumed (g).
3/ Corrected relative to an assigned value for ANRC Casein of 2.50.
4/ Mean ± Standard Error.
5/ Lysine monohydrochloride added after extrusion.

Table V. Rat Growth Evaluation of Cottonseed Blends Extruded on Brady and Insta-Pro (4 weeks' growth)

Sample Description	Weight gain (g)	PER 1/	Corrected PER 2/
Glanded Cottonseed, Insta-Pro, 140°C	73.2±3.7 3/	2.07±.09	1.80±.08
Glanded Cottonseed, Brady, 140°C	96.5±3.7	2.26±.75	1.97±.04
Corn/glanded Cottonseed 70/30, Insta-Pro 149°C	93.6±5.8	2.55±.08	2.22±.07
Corn/glanded Cottonseed 70/30, Brady 139°C	70.9±4.4	2.12±.05	1.84±.04
ANRC Casein	111.4±4.2	2.88±.09	2.50

1/ Protein Efficiency Ratio = weight gain (g) / protein consumed (g).
2/ Corrected relative to an assigned value for ANRC Casein of 2.50.
3/ Mean ± Standard Error.

Table VI. Rat Growth Evaluation of Chickpea Blends (4 weeks' growth)

Sample Description	Weight gain (g)	PER 1/	Corrected PER 2/
45% wheat, 45% chickpea, 10% NFDM	141.7±2.9 3/	3.01±0.5	2.50±.04
45% sorghum, 45% chickpea, 10% NFDM	156.2±6.7	3.12±.05	2.59±.04
45% rice, 45% chickpea, 10% NFDM	167.8±6.4	3.54±.11	2.94±.09
ANRC Casein	119.6±5.6	3.01±.10	2.50

1/ Protein Efficiency Ratio - weight gain (g) / protein consumed (g).
2/ PERs corrected relative to Casein at 2.50.
3/ Mean ± Standard Error.

Table VII. Extrusion of Soybeans on Brady and Insta-Pro

Sample Description	Trypsin Inhibitor		Urease pH units	Corrected PER 1/
	TIU/mg	% destroyed		
Raw, whole soy	74.8	-	1.92	-
Whole soy, Brady, 138°C	22.7	69.7	0.03	1.83±.07 2/
Whole soy, Insta-Pro, 143°C	14.0	81.3	0.09	2.24±.05
Raw, dehulled soy	80.0	-	1.97	1.49±.06
Dehulled soy, Brady, 138°C	36.2	54.7	< 0.01	1.78±.10
Dehulled soy, Insta-Pro, 146°C	11.2	86.0	0.02	2.25±.08

1/ Protein efficiency ratio corrected relative to Casein at 2.40 (4 weeks' growth).
2/ Mean ± Standard Error.

Table VIII. Effect of Added Moisture on Destruction of Trypsin Inhibitor

Sample Description	Temperature (°C)	Water added (%)	Final moisture (%)	% Trypsin inhibitor destroyed
Whole soybeans	139°	0.0	4.7	30.6
Whole soybeans	139°	1.5	4.5	33.7
Whole soybeans	139°	3.0	5.2	53.7
Dehulled soybeans	145°	0.0	2.7	39.1
Dehulled soybeans	138°	1.5	3.6	47.6
Dehulled soybeans	139°	3.0	4.0	67.8

solubility index. The results are summarized in Table IX. These results suggest that an extrusion temperature of at least 143°C is desirable for maximum PER. At this temperature, the PER was 1.94 compared to a PER of 1.01 for unextruded soy. At the higher temperature of 149°C, the PER appeared to drop off slightly. The nitrogen solubility index of 21.6 for the soy flour with the maximum PER was in a satisfactory range. It may be that addition of small amounts of moisture prior to extrusion would lower the minimum effective extrusion temperature to make full-fat soy flour, but at this point, this does not appear to be of any particular advantage. In the future, the protein quality and storage stability of full-fat soy flour extruded at different temperatures in the presense or absence of added water will be evaluated. Based on work to date, an extrusion temperature of 143°C is recommended for the production of full-fat soy flour on a low-cost extruder cooker.

D. Retention of Vitamins During Extrusion and Storage

Loss of heat-labile vitamins during conventional extrusion is known. In view of the fact that LEC's operate without added moisture, it became of interest to ascertain the loss of vitamins during extrusion on a low-cost extruder cooker. If it were possible to add the micronutrients prior to extrusion, it would be of some advantage from a processing standpoint. In addition, since the product coming out of the extruder is nearly sterile, a more sanitary product in the final package could result if the batch blending in of micronutrients post extrusion could be eliminated.

For these reasons, several experiments on vitamin retention during extrusion were carried out using blends of whole corn/whole soy (70/30) or degermed corn/dehulled soy (70/30). The vitamin and mineral premixes were those specified by USDA for Title II blended foods and were obtained from Hoffman-LaRoche and Roland Industries, respectively.

In the first experiment, 150 kg of the pre-ground proportioned corn/soy blends were mixed in a ribbon blender with 0.125% vitamin-antioxidant premix and 2.70% mineral premix. The fortified blends were extruded at 171°C on the Brady #206 extruder with the machine stabilized at this temperature for 15 minutes prior to extrusion of the experimental blends. Triplicate samples of each blend were taken prior to and after extrusion and stored in polyethylene bags in a cardboard box until shipment by motor freight to Hoffman-LaRoche for vitamin determinations.

The second experiment was carried out in a similar manner to the first except that the extrusion temperature was lowered to 163°C, the vitamin addition level was reduced to 0.12% and the samples were air freighted to Hoffman-LaRoche. All samples in both experiments were coded prior to shipment, and the analytical laboratory had no knowledge of sample history.

In the third experiment, the vitamin and mineral premixes were added either before or after extrusion at Title II recommended levels. Samples were analyzed at CSU for thiamin and vitamin C immediately following extrusion or after one month's storage at: (1) -32°C in the freezer, (2) 31°C, 48% relative humidity, or (3) 49°C, 60% relative humidity. Retentions for samples after storage are expressed as percentages of the initial values and thus only reflect storage losses and not losses during extrusion.

The results of the first two experiments are summarized in Table X. Retentions of riboflavin, vitamin B_6, and folic acid were all higher than 90% for both blends and in both experiments. Retention of vitamin A was only slightly less, ranging from 86-89% with whole corn/whole soy and 94-104% with the degermed corn/dehulled soy blend. Vitamin E was measured only in the second experiment, but retention was better than 100% for both blends.

Retention of vitamin C was generally 80% or more. The vitamin C retention of 110.7% in one case was undoubtedly in error and resulted from an artificially-low vitamin C level in the before-extrusion samples. In any case, the high retentions of heat-labile vitamin C generally observed during extrusion likely reflect the low moisture levels and the short time of the heat treatment.

In contrast to all the other vitamins, the retention of thiamin differed markedly in the two experiments. In the first experiment, thiamin retention was 90-98% with the two blends. In contrast, in the second experiment, thiamin retention was 48% and 75% in the whole corn/whole soy and the degermed corn/dehulled soy blend respectively. We have no explanation for these differences, since we attempted to keep the experimental conditions closely similar in the two experiments. Thiamin is heat-and pH-sensitive, as well as being water soluble. In the second experiment, the extrusion temperature was lower, not higher, and losses through water solubility were not a factor in either experiment. It is possible that the pH was, for an unknown reason, slightly higher in the second experiment thus increasing the destruction of thiamin. In any case, the data emphasize the variability in thiamin retention that can occur during extrusion, even under reasonably well-controlled conditions.

Table IX. Effect of Temperature on Extrusion of Soybeans 1/ (Brady)

Temperature °C	Nitrogen solubility index	Urease pH units	Trypsin inhibitor		Corrected PER 2/
			TIU/mg	% destroyed	
Unextruded	55.6	2.07	64.5	-	1.01±.08 3/
121°	41.9	1.96	64.8	0.0	1.35±.04
127°	56.1	1.82	57.2	11.2	1.42±.05
132°	44.3	1.46	45.5	29.5	1.41±.04
138°	47.1	0.34	47.2	26.7	1.55±.04
143°	21.6	0.02	28.0	56.7	1.94±.05
149°	16.6	0.01	16.8	74.0	1.78±.08

1/ Composition of dehulled soybeans: protein 39.2±.03, ash 5.9±0.1, fiber 2.4±0.1, moisture 5.9±0.5, fat 21.0±02.
2/ Protein efficiency ratios corrected related to Casein at 2.50.
3/ Means ± Standard error.

Table X. Retention of Vitamins During Extrusion of Corn/Soy Blends

Vitamin	% Retained	
	Experiment 1 1/	Experiment 2 2/
	Whole corn/whole soy (70/30)	
Thiamin	90.2	48.3
Riboflavin	95.3	92.2
Vitamin B_6	110.2	129.7
Folic acid	100.3	103.6
Vitamin C	83.1	80.4
Vitamin A	89.3	86.5
Vitamin E	-- 3/	113.1
	Degermed corn/dehulled soy (70/30)	
Thiamin	97.8	75.4
Riboflavin	98.3	100.0
Vitamin B_6	91.3	128.2
Folic acid	101.2	122.1
Vitamin C	110.7	78.9
Vitamin A	104.0	94.1
Vitamin E	-- 3/	126.9

1/ Extruded with Brady at 171°C.
2/ Extruded with Brady at 163°C.
3/ Not determined.

Data on the storage stability of thiamin and vitamin C are summarized in Table XI. The retention values summarized in this table are expressed as percentages of the values at the time the samples were placed into storage and thus consider losses during storage only and do not include losses during extrusion.

Retentions of thiamin in all cases were greater than 70% after one month's storage. With a temperature of 31°C (88°F) and 48% relative humidity, thiamin retention ranged from 81-85%. These conditions would approximate storage conditions under tropical conditions. Under the accelerated storage conditions of 49°C (120°F) and 60% relative humidity, thiamin retentions ranged from 71-72%. In the case of thiamin, there were no clear differences in retention related to vitamin addition before or after extrusion.

The results were considerably different for vitamin C as shown by the data in Table XI. When the vitamin mix was added after extrusion, retention of vitamin C was similar to that for thiamin. At 31°C, retentions were 80-86% and at 49°C, 64-65%, respectively. In strong contrast, when the vitamin mix was added prior to extrusion, vitamin C was almost totally lost during one month's storage under accelerated storage conditions. Under the tropical storage conditions, 31°C, 48% relative humidity, vitamin C retentions during storage were 34-43% and under the accelerated storage conditions of 49°C, 60% relative humidity, retentions dropped to 2-9%.

The reasons for this poor stability of vitamin C during storage are not completely understood. Loss of volatile antioxidants during extrusion could be involved. At one point, we suspected that the vitamin C in the mix was microencapsulated to protect against loss and that this protective coating was lost during extrusion. However, according to the vitamin supplier, this was not the case, although several other vitamins are present in the mix in coated forms that presumably would be destroyed during extrusion.

In any case, regardless of the reason, the very poor stability of vitamin C during storage when the vitamin mix was added prior to extrusion, combined with the variability of thiamin recovery, indicates strongly that the vitamin premix should be added following extrusion. There would not appear to be any advantages to adding some of the vitamins and the minerals prior to extrusion and some after extrusion, so our strong recommendation is that vitamin and mineral fortification be carried out after extrusion. In addition, the antioxidants BHT and BHA need to be clearly specified and perhaps added separately, since we have been informed by at least one major supplier that they are no longer added to the vitamin premix sold to manufacturers of blended foods.

E. Viscosity Reduction Studies

Supplemental foods are important sources not only of protein, vitamins and minerals, but also sources of total food energy, that is, calories. When these foods are mixed with water and served as a gruel or beverage, the number of calories per unit volume may become an important consideration.

Table XI. Storage Stability of Thiamin and Vitamin C added to Corn/Soy Blend Before or After Extrusion 1/ (One Month's Storage)

Blend	Storage Conditions	Time of Addition	Retention (%)
	Thiamin		
Whole corn/whole soy	-32°C, freezer	Before extrusion	84.0
Whole corn/whole soy	-32°C, freezer	After extrusion	91.6
Whole corn/whole soy	31°C, 48% R.H.	Before extrusion	84.8
Whole corn/whole soy	31°C, 48% R.H.	After extrusion	84.6
Whole corn/whole soy	49°C, 60% R.H.	Before extrusion	71.3
Whole corn/whole soy	49°C, 60% R.H.	After extrusion	73.8
Degermed corn/dehulled soy	-32°C, freezer	Before extrusion	98.7
Degermed corn/dehulled soy	-32°C, freezer	After extrusion	94.1
Degermed corn/dehulled soy	31°C, 48% R.H.	Before extrusion	85.1
Degermed corn/dehulled soy	31°C, 48% R.H.	After extrusion	80.6
Degermed corn/dehulled soy	49°C, 60% R.H.	Before extrusion	82.2
Degermed corn/dehulled soy	49°C, 60% R.H.	After extrusion	76.7
	Vitamin C		
Whole corn/whole soy	-32°C, freezer	Before extrusion	71.0
Whole corn/whole soy	-32°C, freezer	After extrusion	101.1
Whole corn/whole soy	31°C, 48% R.H.	Before extrusion	43.4
Whole corn/whole soy	31°C, 48% R.H.	After extrusion	86.3
Whole corn/whole soy	49°C, 60% R.H.	Before extrusion	8.6
Whole corn/whole soy	49°C, 60% R.H.	After extrusion	65.3
Degermed corn/dehulled soy	-32°C, freezer	Before extrusion	84.9
Degermed corn/dehulled soy	-32°C, freezer	After extrusion	89.7
Degermed corn/dehulled soy	31°C, 48% R.H.	Before extrusion	34.0
Degermed corn/dehulled soy	31°C, 48% R.H.	After extrusion	80.2
Degermed corn/dehulled soy	49°C, 60% R.H.	Before extrusion	2.2
Degermed corn/dehulled soy	49°C, 60% R.H.	After extrusion	64.5

1/ Extruded with Brady at 163°C.

We reported at the First International Conference on Low-Cost Extrusion Cooking Technology at Colorado State University in 1976 that perhaps the major difference between CSB made on a LEC and Title II CSB or CSM was that LEC-made CSB exhibited a much higher uncooked viscosity. This could have the effect of lowering the calorie density of the gruel and thus potentially reducing the amount of food that a small child might be able to consume at a single meal.

This problem can be overcome easily by boiling the gruel for 5 minutes, and this is certainly desirable from a sanitation standpoint. However, in some cases, the water may be boiled separately, cooled slightly and then mixed with CSB to make the gruel. In this situation, the high uncooked viscosity noted for CSB may not be a completely desirable product characteristic.

For this reason, some preliminary experiments were carried out on viscosity reduction using enzymes of microbiological origin. The enzymes obtained for these studies are listed in Table XII. Most of the enzymes were amylases, although several had either proteolytic or hemicellulolytic activity.

Table XII. Enzymes Used in Viscosity Studies

Product	Company
Enzeco Fugal Amylase	Enzyme Development Corp.
Enzeco Bacterial Amylase	Enzyme Development Corp.
Rhozyme P-53 Concentrate	Rohm and Haas
Rhozyme H-39	Rohm and Haas
HT Proteolytic 200	Miles Laboratories
CE-100	Miles Laboratories
HT-1000	Miles Laboratories
Taka-Therm	Miles Laboratories

The enzymes were dry-blended into CSB using a Hobart Mixer at levels ranging from 0.01% to 0.025%. The enzyme-CSB blend was mixed with water either at 24°C or at 75°C in a ratio of 37 grams CSB to 100 ml water. Viscosity was measured 30 minutes later using a Brookfield viscometer using a #7 spindle at 50 rpm.

The results are summarized in Table XIII. Under the conditions used, the viscosity of LEC CSB untreated was 26,000-41,000 cps, compared to 4,800 cps for Title II CSM. In general, enzyme preparation with predominantly amylolytic activity were the most effective in lowering viscosity, and the preparation described as hemicellulolytic had virtually no activity at the level tested.

The most active preparation was H39 obtained from Rohm and Haas, which yielded viscosity values 1,000-2,000 cps at 0.01%. Enzyme preparation K4814 was also quite effective in lowering viscosity, giving values of 3,000-8,000 cps at 0.01% and 1,000-4,000 cps at 0.025%.

In another experiment, CSB containing 0.025% K4814 was stored for up to 13 days either in the freezer or at 29° to 49°C with approximately 50% relative humidity. At 2 or 13 days storage, viscosity of the samples was determined as previously described. The results summarized in Table XIV indicate that viscosity changed very little as a function of up to 13 days' storage.

These results suggest that it may be feasible to blend in a small amount of an amylase at the time the vitamins and minerals are added. These enzyme preparations are approved in the United States for food use. At the currently quoted price of $5/lb for H39, this would add an ingredient cost of 0.1¢/lb to the CSB, not including the shipping cost for the enzyme.

Table XIV. Effect of Storage on Viscosity of Enzyme-Treated CSB 1/ (0.025% K4814)

Time of storage (days)	Conditions of storage	Viscosity (cps)
0	---	1,710
2	Freezer	1,760
2	29°C	1,600
2	49°C	2,080
13	Freezer	1,820
13	29°C	1,920
13	49°C	2,320

1/ 37 grams CSB (dehulled corn and dehulled soy (70/30)) fortified with Title II vitamins and minerals mixed with 100 ml water. Viscosity measured at 30 minutes on a Brookfield visocometer at 50 rpm with #7 spindle.

Table XIII. Viscosity of Enzyme-Treated CSB 1/

Enzyme Number	% Enzyme	Type Activity	Viscosity (cps) 2/
		Water added at 24°C	
Control	None	-	25,800
K4814	0.025	Amylolytic	4,380
K4814	0.010	Amylolytic	8,160
K4815	0.025	Amylolytic	3,360
K4815	0.010	Amylolytic	11,800
HT 1000	0.025	Amylolytic + proteolytic	2,740
H-39	0.025	Amylolytic	1,280
H-39	0.010	Amylolytic	2,320
P-53	0.010	Proteolytic	17,000
		Water added at 75°C	
Control	None	-	41,040
K4814	0.025	Amylolytic	1,384
K4814	0.010	Amylolytic	3,170
K4815	0.025	Amylolytic	1,620
K4815	0.010	Amylolytic	14,800
HT 1000	0.025	Amylolytic + proteolytic	11,000
H-39	0.025	Amylolytic	533
H-39	0.010	Amylolytic	1,064
P-53	0.010	Proteolytic	18,700
P-53	0.025	Proteolytic	3,544
CE-100	0.025	Hemicellulolytic	29,200

1/ 37 grams CSB (dehulled corn and dehulled soy (70/30)) fortified with Title II vitamins and minerals mixed with 100 ml water. Viscosity measured at 30 minutes on a Brookfield viscometer at 50 rpm with #7 spindle.

2/ Viscosity of ICSM control was 4,880 cps with water added at 25°C.

F. Analysis of Products Made in Costa Rica and Tanzania

The work described in this paper so far has been carried out with samples extruded in a pilot plant at Colorado State University. Recently, we obtained samples of products made in the recently-installed plants in San Jose, Costa Rica and Dar es Salaam, Tanzania. The products from Costa Rica were full-fat soy flour and two samples of CSM. The latter two samples were prepared by extruding CSB on the Brady extruder and than dry-blending in either 10% or 18% non-fat dry milk with the vitamins and minerals. The corn and soy used were dehulled using a Sturdevant dehuller. The products from Tanzania were corn/soy blend and corn/soy milk (5% non-fat dry milk).

Proximate analysis, nitrogen solubility and viscosity data are summarized in Table XV for the samples from Costa Rica. The fiber levels in the CSM, 1.3-1.5% are well below the fiber specification of 2.0% for Title II blended foods. Nitrogen solubility values for the two CSB samples are high, 20-28%, primarily because of the milk solids added. As reported previously, the uncooked viscosity values for the CSM were high, and cooking the samples greatly reduced the viscosity. The proximate analysis of these products yielded values expected based on the known ingredients. Corrected PER's for the CSM samples were 2.24±.05 and 2.33±.06 for the products with 10% and 18% NFDM respectively. These values confirm the expected high-protein quality of these products. There was no significant difference between the CSM samples as a function of level of milk addition.

The results of full-fat soy flour extruded in Costa Rica also are listed in Table XV. Extrusion at 140° resulted in a 53% destruction of anti-trypsin activity and a urease value of .07, which is well below the USDA allowable level. The corrected PER, 1.77±.05, is slightly below the maximum PER observed in other experiments, 1.94±.05 (Table IX), but is still indicative of a high-quality soy product. The slightly-lower PER could be related to differences in the assay, since the studies were carried out at different times with different rats. However, it is also quite possible that it is related to a slightly lower extrusion temperature (140°) than would be optimum. As discussed in an earlier section of this manuscript, based on our most recent work, we now recommend an extrusion temperature of 143° - 146°.

Table XV. Analysis of Products Extruded in Costa Rica

	Full-fat soy	Corn/soy milk 1/	Corn/soy milk 2/
Moisture - %..	3.0	8.1	7.7
Fat - %.......	22.5	7.7	6.6
Fiber - %.....	2.5	1.5	1.3
Ash - %.......	4.8	5.4	5.5
Nitrogen - %..	6.8	3.5	3.5
Protein % 3/..	42.2	21.8	21.8
Protein - dry weight %.....	43.6	23.7	23.6
Trypsin inhibitor % loss..	53	--	--
Urease (ml)...	.07	--	--
Nitrogen solubility - %...	18.4	19.6	28.4
Viscosity, uncooked 4/..	--	18,600	16,990
Viscosity, cooked 5/....	--	340	368
Viscosity, uncooked 6/..	--	1.0	1.0
Viscosity, cooked 6/....	--	> 24	> 24
Corrected PER 7/..........	1.77±.05	2.24±.05	2.22±.06

1/ Corn-soy blend (70/30) fortified with vitamins, minerals and 9.8% non-fat dry milk.
2/ Corn-soy blend (70/30) fortified with vitamins, minerals and 17.6% non-fat dry milk.
3/ N x 6.25.
4/ Viscosity determined using a Brookfield viscometer with a #6 spindle at 50 rpm.
5/ Viscosity determined using a Brookfield viscometer with a #5 spindle at 50 rpm.
6/ Viscosity determined with Bostwick viscometer.
7/ Protein Efficiency Ratio (PER) corrected relative to 2.50 for ANRC Casein.

The results for the products extruded at the plant in Tanzania are shown in Table XVI. In general, the results on nitrogen solubility and viscosity are consistent with previous work. The corrected PER for the CSB sample was 2.04+.06. Addition of 5% NFDM increased the PER to 2.17+.06, but the increase was not statistically significant (P>10). The PER for the CSB was somewhat lower than values usually obtained for CSB made from 70% corn and 30% soy, which usually are in the 2.25-2.50 range. This particular CSB sample also was slightly lower in fat and protein than expected, suggesting the possibility that the composition was higher in corn and lower in soy than expected.

Table XVI. Analysis of Products Extruded in Tanzania

	Corn/soy blend 1/	Corn/soy milk 2/
Moisture - %	5.8	6.0
Fat - %	5.8	5.8
Fiber - %	1.5	1.3
Ash - %	1.9	3.9
Nitrogen - %	2.7	2.8
Protein - % 3/	16.7	17.8
Protein - dry wt. - % 3/	17.8	18.9
Nitrogen solubility - %	7.1	15.8
Viscosity - uncooked 4/	29,700	11,600
Viscosity - cooked 5/	1,200	1,020
Viscosity - uncooked 6/	< 0.5	4.5
Viscosity - cooked 6/	21	18
Corrected PER 7/	2.04+.06	2.17+.06

1/ Corn/soy blend (70/30).

2/ Corn/soy blend (70/30) fortified with vitamins, minerals and 5% non-fat dry milk.

3/ N x 6.25.

4/ Viscosity measured with a Brookfield viscometer using a #7 spindle at 50 rpm (out of range with #6 spindle).

5/ Viscosity measured with a Brookfield viscometer using a #5 spindle at 50 rpm.

6/ Viscosity determined with a Bostwick viscometer.

7/ Protein Efficiency Ratio (PER) corrected relative to Casein = 2.50.

II. NUTRITIONAL SPECIFICATIONS FOR BLENDED FOODS

Nutritional specifications for Title II blended foods were established over ten years ago. Protein, fat, fiber and moisture levels specified are listed in Table XVII, and the vitamin and mineral fortification requirements are listed in Table XVIII.

Those individuals responsible for establishing these specifications should be commended for their foresight. For example, they insisted on the addition of at least 6% oil at a time when many people thought of these foods primarily in terms of the protein component. Very complete vitamin and mineral mixtures were specified including, for example, zinc, long before the importance of zinc deficiency in human populations was recognized.

Nevertheless, it is important at this time to review these specifications for several reasons. First, in the years since they were established, there has been a shift in nutritional thinking which has deemphasized the importance of protein and placed much more emphasis on total food energy. In addition, in contrast to the Title II program, where the foods are made in the United States and distributed all over the world, LEC blended foods are made locally, and nutritional specifications could theoretically be tailor-made for the local situation.

With these considerations in mind, the nutritional specifications for LEC-made blended foods such as CSB and CSM will be reviewed. To assist in assessing the nutritional impact of the blended food on a target population, the nutritional quality of a low-income dietary pattern in Sri Lanka has been calculated. The dietary pattern for the lowest income group in Sri Lanka was supplied by Dr. Beatrice DeMel and Mr. Jay Jackson from CARE/Sri Lanka. This pattern is used as an example only. At Colorado State University, we would be interested in obtaining similar data for other potential recipients of LEC-made blended foods in other countries.

The low-income pattern shown in Table XIX supplies 1759 kilocalories and 39.2 grams protein per day. For the purpose of assessing the nutritional impact of the blended food on the preschool population, it was assumed that the children, aged 1-6, would obtain 1000 kilocalories per day from the so-called family pot (i.e., Table XIX) and 300 kilocalories per day from the blended food.

Table XVII. Specifications for Title II Commodities (per 100 grams)

	Title II Commodity				
	CSB	CSM	ICSM	WSB	WSDM
Protein (N x 6.25) 1/	16.7	19.0	19.0	20.0	20.0
Fat 1/	6.0	6.0	6.0	6.0	20.0
Crude fiber 2/	2.0	2.0	2.0	2.5	2.0
Moisture 2/	10.0	10.0	10.0	11.0	10.0
% protein calories	17.9	20.4	20.0	22.2	18.4
% fat calories	14.4	14.5	14.2	15.0	41.4

1/ Minimum.
2/ Maximum.

A. Vitamins and Minerals

In Table XX, vitamin and mineral levels in 300 kilocalories of unfortified CSB are added to the calculated levels in 1000 kilocalories of the low-income dietary pattern and compared to the requirements specified by FAO for preschool children, ages 1-6.

These very tentative calculations suggest that perhaps the vitamin A, folic acid and iron levels in the supplement could be greatly reduced in the supplement, if not eliminated. In view of the importance of vitamin A deficiency and nutritional anemia in many countries including Sri Lanka, this would not be a recommended course of action. The vitamin A intake of the home diet is heavily dependent on chile peppers, and there are undoubtedly many times when the cost of chile peppers would exclude them from the dietary pattern of low-income people for prolonged periods of time. We know relatively little about the levels and availability of folic acid, specifically bound forms, in foods. Iron availability is known to be very poor in diets primarily of vegetable origin. Animal foods, especially meat, increase iron availability, as does vitamin C. In the dietary pattern, animal foods only supply 3% of calories, and the vitamin C intake is very low and again, almost totally dependent on the consumption of chile peppers.

These calculations support, in general, the fortification levels for vitamins and minerals currently specified for Title II foods. However, for any LEC program that plans to custom-specify its own blend, the following suggestions are made, contingent on more definitive calculations for the "family pot" diet in that particular country.

Table XVIII. Vitamin and Mineral Fortification Levels for Blended Foods

Mineral Premix	Amounts/2000 lbs.
Tricalcium phosphate	40.00 lb. 1/
Zinc sulfate hydrated	0.08 lb.
Ferrous fumarate	0.92 lb.
Iodized salt (0.007% I_2)	13.00 lb.
	Total 54.00 lb.
Vitamin Antioxidant Premix	Amounts/2000 lbs.
Thiamin mononitrate	2.5 g.
Riboflavin	3.5 g.
Pyridoxin hydrochloride	1.5 g.
Niacin	45.0 g.
Calcium D-pantothenate	25.0 g.
Folacin	1.8 g.
Vitamin B_{12}	36.0 mg
Vitamin A palmitate	15×10^6 I.U.
Vitamin D	1.8×10^6 I.U.
Alpha-tocopherol acetate	68,000 I.U.
Butylated hydroxy anisole	20.0 g.
Butylated hydroxy toluene	20.0 g.
Ascorbic acid	364.0 g.
Soy flour or starch	q.s. 2 lbs.
	Total 2.0 lbs.

1/ An alternative formulation is 12.0 lbs. calcium carbonate (or ground limestone) and 12.0 lbs. dibasic calcium phosphate hydrated.

The vitamin C level in the supplement should be doubled to increase the absorption of dietary iron. To help recover some of the additional cost of the added vitamin C, the vitamin B_{12} level could easily be reduced by 50% with little, if any, risk. The mineral supplement currently specified for Title II foods includes 40 lbs. tricalcium phosphate /2000 lbs. This provides more calcium than needed from a nutritional perspective and is present at this high level primarily to slow down insect infestation. Unfortunately, there is some evidence that this high level of tricalcium phosphate may inhibit the absorption of iron and zinc, but more data are needed. Pending more definitive studies on iron and zinc availability in blended foods and more data on insect infestation in locally-made LEC blended foods, at this time it is recommended that rather than use this high level of tricalcium phosphate, the alternate formulation of 12 lbs. calcium carbonate (or ground limestone) and 12 lbs. dibasic calcium phosphate hydrated be used instead. This should not only be advantageous from the standpoint of trace element availability but will also lower the cost.

Table XIX. Low-Income Dietary Pattern in Sri Lanka (One Day's Consumption)

Food	Weight (g)	Energy Kcal.	Protein (g)	Fat (g)
Rice, parboiled	245	892	16.4	2.4
Wheat flour	68	247	6.6	0.7
Maize	9	31	0.8	0.4
Chile peppers	9	10	0.6	0.1
Onions	18	7	0.3	0.0
Fresh fish	14	14	2.6	0.4
Dried fish	9	17	3.2	0.4
Fresh milk	9	5	0.3	0.3
Eggs	1	2	0.1	0.1
Coconut oil	4	36	0.0	4.0
Coconut	109	340	3.5	30.7
Beef	4	6	0.8	0.3
Dhal	14	48	2.8	0.1
Green gram	4	14	0.8	0.1
Manioc	27	90	0.4	0.1
Total	544	1759	39.2	40.1

B. Fiber

Although fiber is hypothesized to have some significant nutritional advantages when consumed by adults, there also is no doubt that it has some nutritional disadvantages, especially in feeding young children. Fiber can reduce the availability of minerals such as calcium, magnesium, iron, zinc and copper. High levels of fiber in the diet can reduce the nutrient density of the food by adding bulk and also can cause gastrointestinal irritations. In the weaning process in most developing countries, a child has to make the transition from breast milk, which has no fiber and which is both calorie-dense and very digestible, to a cereal-type diet high in fiber, low in fat and not well digestible. In general, the younger the child or infant, the lower should be the intake of fiber. At the same time, one of the major functions of weaning foods in developing countries is to ease the transition from low-fiber, high-fat breast milk to a high-fiber, low-fat "family pot." In the following discussion, the fiber levels in blended foods will be discussed in terms of crude fiber, realizing that "crude" fiber greatly underestimates total "dietary" fiber, especially the hemicellulosic, pectin and lignin components. Work is currently in process to characterize blended foods in terms of total dietary fiber and determine the effect of extrusion, if any, on dietary fiber.

With these conditions in mind, the Title II specification of 2.0% crude fiber would appear to be much more appropriate for blended foods potentially being used as weaning foods than the PAG allowable level of 5%.

When corn and soy are dehulled in a LEC plant using a Sturdevant dehuller, a crude fiber level in the range of 1.6-2.0% will be obtained, depending on the efficiency of dehulling. High moisture levels in the corn and soy may reduce the efficiency of the dehulling operation, resulting in higher fiber levels. The fiber levels found in the two CSM products made in the plant in Costa Rica were 1.3-1.5% which calculates to be 1.6-1.7% for the CSB component. It will be desirable to keep below the 2.0% crude fiber level for blended foods that will be fed as supplemental foods to infants 4-12 months of age. The processed weaning foods being made in a LEC installation are not intended to serve as the sole source of food for infants in the first year of life.

C. Protein

Over the past ten years, considerable discussion has taken place concerning the relative importance of deficiencies in protein or calories in causing protein-calorie malnutrition around the world. Today, it is probably fair to say that deficiencies in both protein and calories are significant factors, but protein deficiency does not appear to be as serious a problem as was thought to be the case 10 years ago.

Title II blended foods typically contain 17-20% protein, but these high levels were set at a time when a high protein intake was considered to be more important than is the case today. Breast milk

Table XX. Supplementation of Sri Lanka Low-Income Diet Nutrient Intakes With and Without Corn/Soy Blend

Nutrient	100 Kcal Sri Lanka Diet	300 Kcal Unfortified CSB (70/30)	Total	Requirement 2/	Fortification Needed		Current CSB/Kg
					Per 75 g Supplement	Per 1 kg Supplement	
Calcium (mg)	75	53	128	450	322	4290	7800
Iron (mg)	6.2	2.4	8.6	7.5	--	--	152
Vitamin A (μg)	184	149	333	280	--	--	2720
Vitamin D (I.U.)	0	0	0	400	400	5330	1990
Thiamin (mg)	0.44	0.32	0.76	0.60	--	--	2.8
Riboflavin (mg)	0.26	0.09	0.35	0.95	0.60	8.0	3.8
Niacin equivalent (mg) 1/	7.7	3.3	11.0	10.5	--	--	49.3
Vitamin C (mg)	7.8	0	7.8	20	12.2	163	400
α Tocopherol (mg)	1.0	2.7	3.7	8.0	4.3	57.3	74.7
Pyridoxine (mg)	0.66	0.26	0.92	0.75	--	--	1.6
Pantothenic acid (mg)	1.8	0.5	2.3	4.0	1.7	22.7	28.0
Vitamin B_{12} (μg)	0.4	0.0	0.4	1.2	0.8	10.7	40.0
Folic acid (mg)	0.06	0.05	0.11	0.10	--	--	2.0
Zinc (mg)	7.0	2.4	9.4	10.0	0.6	8.0	9.2

1/ Includes niacin equivalent from tryptophan.
2/ FAO requirement for children ages 1-6.

supplies protein at 6-7% of calories. In assessing the adequacy of dietary protein supply, we can consider the minimum protein requirement in terms of completely utilizable protein as 7% of calories and then make adjustments for digestibility and amino acid pattern. The FAO-suggested amino acid pattern is probably the best pattern to use in scoring dietary protein, but additional allowance needs to be made because of the generally poorer digestibility of plant protein.

For cereal-type diets, protein is more limited by quality and digestibility than by quantity. This point is illustrated by the data in Table XXI. The so-called low-income dietary pattern in Sri Lanka had an amino acid score of 82 with lysine limiting and an ND_pCal % of 7.3 If this protein were totally digestible, it would be barely adequate and provide no margin for catch-up growth following sickness. However, the protein in this pattern isn't totally digestible and, in fact, this diet furnishes no margin or safety in protein for a preschool child or a pregnant or lactating woman. Addition of a daily supplement of 300 Kcal of CSB (70/30) or ICSM would increase the ND_pCal % to 9.3-10.6, levels that do provide some margin of safety and allowance for digestibility. If the supplement were CSB made from 80 parts corn and 20 parts soy, the ND_pCal % would be 8.5, also probably high enough to meet minimum protein needs.

It is difficult to generalize about how much protein should be in a supplemental food, since each case has to be evaluated individually. At the first LEC meeting, it was suggested that the protein level in blended foods could be reduced to 12% of calories in countries where the local diet was primarily cereals with small amounts of legumes, and if the potential quality was 80% as good as casein and digestibility was demonstrated to be good in human infants. For blended foods made in a LEC program with crude fiber levels 1.5-2.0%, it would probably be wise to modify this recommendation and keep the protein level in the supplemental food up to about 14-15% of calories. This level can be attained in a LEC-extruded product even if full-fat soy is lowered from 30% to 20% and 1-2% oil is added to increase the calorie density of the final product.

D. Calories

Much has been written about the importance of calories in supplemental feeding programs. Studies in India and in Guatemala have suggested that calories are more important than protein in a supplemental food. The recent five-country evaluation of feeding programs carried out by CARE also suggested that more attention should be given to increasing calorie density of the supplemental food and less attention paid to the protein component.

This protein-vs-calorie issue can not be adequately discussed here but has been considered in more detail elsewhere (Jansen, G.R., in "Evaluation of Protein for Humans," C.E. Bodwell (Ed.), Avi Publishing Co., Westport, Conn. 1977). Without understating the importance of high quality protein in the diet and in many preschool feeding programs, it is desirable to increase the consumption of calories. Two major ways to do this would be to add oil or add sugar. To the extent that more oil can be added to a blended food consistent with cost and technological constraints, it will be desirable to do so. In extruded blends of corn and soy, it is important to not reduce the soy component below 30%, more for the fat than the protein content of the soy. Addition of local vegetable oil, such as coconut or palm oil, may have merit; however, in some cases the essential fatty acid intake may be quite marginal. Coconut and palm oil are saturated and don't provide the essential fatty (linoleic) acid as do corn and soybean oils.

Addition of sugar to a blended food would be desirable, because in most cases it will stimulate consumption. Also, the calorie density of the final gruel will be increased by sugar, since this small molecule does not increase viscosity. Extrusion followed by a brief boil also likely increases the calorie density by increasing the solids content of the final gruel as compared to local cereals.

In summary, it is almost impossible to generalize about the nutritional requirements for a blended food. Each case has to be looked at separately in relation to the local situation. What has been attempted is a brief overview of what the major nutritional issues are.

To assist LEC programs in designing food products from a nutritional perspective and in integrating them into feeding programs, Colorado State University offers a broad range of nutritional and product evaluation services. These include proximate analysis, vitamin and mineral analysis, determination of gossypol, anti-trypsin and urease activity and rat growth evaluation of protein quality. In addition, evaluation of functional properties of blends, including nitrogen solubility, protein dispersibility, viscosity and water absorption measurements, and

Table XXI. Supplementation of Sri Lanka Low-Income Diet

	No Supplement	75g of Supplement		
		70/30 1/	80/20 1/	ICSM
Protein/day (g) 2/	22.3	35.1	32.9	37.3
Fat/day (g)	22.9	28.0	26.3	27.4
Energy/day (Kcal)	1000	1302	1295	1285
Protein/day (Kcal)	89.2	140.4	131.6	149.2
Fat/day (Kcal)	206.0	251.5	236.6	246.5
Protein/day (% of cal)	8.9	10.8	10.2	11.6
Fat/day (% of cal)	20.6	19.4	18.3	19.2
Lysine score	82	86	83	91
Sulfur amino acid score	115	104	106	103
Threonine score	99	97	97	98
Tryptophan score	115	114	112	112
Limiting amino acid	Lysine	Lysine	Lysine	Lysine
Protein (%)	8.8	10.8	10.2	10.8
Net protein value 3/	7.2	9.3	8.5	9.8
ND_pCal % 4/	7.3	9.3	8.5	10.6

1/ Code: wt. corn/wt. soy.
2/ Protein = N x 6.25.
3/ NVP = A.A. Score (lysine) x % protein/100.
4/ ND_pCal % = A.A. Score (lysine) x % protein calories/100.

organolytic evaluation including flavor, odor and texture, can be arranged for. In addition, the facilities for doing storage studies under high and low temperatures and humidities and baking studies are also available.

Besides these analytical services, nutritional consulting services on the nutritional specifications for food products and the nutritional evaluation of feeding programs also can be arranged. At the present time, these services are provided under the USDA-AID contract with Colorado State University. The decision on making these services available to a LEC program is made by Mr. Rod Crowley at USDA and Dr. Jud Harper, project director. The USDA-AID-CSU contract will be completed in the near future, but support services will still be available on a cost-recovery basis. The interest in and the demand for these services will determine to what extent and for how long they will continue to be available.

ACKNOWLEDGMENTS

The author would like to acknowledge the excellent technical assistance from Ron Tribelhorn, Joe Kellerby and David Cummings in carrying out the extrusion experiments and Louise O'Deen and Peter Hambleton for all the analytical work.

Question-and-Answer Session

Prof. Amara: I would like to ask about weaning foods which are totally starch-based. From what month can you start to feed them to babies?

Dr. Jansen: This is an area where there really hasn't been a lot of work done to establish at what age. I think it is important to make a distinction between something that's going to be used as a total food for a young child and something that's a supplemental food, and I think that most pediatricians and nutritionists recommend that by the age of about four months, one should start introducing solid foods into the diet. At this age, these are very suitable foods to be introduced on a supplemental basis, but certainly not as a replacement for breastfeeding.

Prof. Amara: You mean if you use it as a supplement you can start it earlier?

Dr. Jansen: I would say that the experience has been that it can be used satisfactorily from four months on as supplemental food I don't think there has been any kind of study to demonstrate what you're asking; however, Dr. Graham has evaluated a whole series of these blended foods, and the results have been published in the American Journal of Clinical Nutrition over many years. He evaluated CSM, ICSM, wheat-soy blend and so on. He's evaluated Thriposha two years ago, and now he's doing our current blended foods. I think he is feeding them to children as young as six months of age, so I think that experience shows that from the age of four months on, they are all right as supplemental foods. There is not much experience with children younger than that.

Prof. Amara: If you look it up in the Codex Alimentarius list of the standard for infant cereal-based foods, it is pointed out that no food additive or enzyme should be added. What developmental effect does this have?

Dr. Jansen: That's interesting--I didn't know that, because these enzymes are approved for food use.

Dr. Sanchez: I know that in Egypt UNICEF installed a complete weaning food plant with the alpha-amylase treatment in the flour. It's a process developed by UNICEF and Buhler Brothers which utilizes enzymes, but they are probably inactivated after the treatment for hydrolyzing the starch has occurred.

Dr. Jansen: That's a good point, and we'll look into it. Responding to a separate comment Pedro Bleyer made to me, I think that thirty percent of whole soy in these products is more important from the standpoint of energy than it is from the standpoint of protein. This is part of a change in thinking over the past 10 or 15 years. I think that protein in these blended foods could be reduced to 15%, but if you reduce to, say, an 80/20 plan, you are reducing fat, and I think there are other alternatives. There isn't time to go into it, but for example, an 80/20 plan with some oil added back has some possibilities as a way to produce a satisfactory weaning food. Another thing, let's make a distinction betwen corn and soy. The advantage of not dehulling corn is that you don't lose the oil, whereas there is no particular advantage other than one of process as far as the soy is concerned. I am hopeful that data will be obtained in the near future that would say the use of whole corn would be fine. It's another matter with the whole soy, and you might have other problems there.

Mr. Bleyer: I never dehull the soy. I dehull the corn because if you don't, you get another kind of product.

Dr. Jansen: Well, it's a trade-off, because there's an extraction rate--you're losing corn, depending on whether you can effectively use what you take off, and you're losing the oil, which is a disadvantage--so it's an open question. I want to emphasize that we're not dealing with absolutes when we discuss nutritional specifications. There's a lot of room for discussion and debate.

Mr. Mosha: I wonder whether we shouldn't start looking at our "LISHA" product more carefully as far as the nutritional aspects are concerned. I have two questions: First, it would be interesting to know the amount of vitamin loss during storage. Some of the products we are producing here take some time for the preparation methods, including slightly cooking the product. It is important that we cook the product from a microbiological aspect, especially when cholera is a threat. Second, do you notice any moisture build-up during storage? Or do you store your samples in air-tight containers?

Dr. Jansen: I don't recall the answer to that second question on what the moisture changes were. I expect the containers were not totally moisture-proof, and there probably were some small changes but not enough to change the percent figures we have. We only did thiamin and vitamin C as far as storage is concerned, and we have not done anything else to look at vitamin stability in cooked blended foods. There has been a fair amount of work done on cooking losses of vitamins in foods, and there's no doubt that you're losing some--particularly thiamin and vitamin C--in cooking, but they're tolerable losses, I think. These storage losses aren't, for vitamin C.

The LEC Program in Chihuahua, Mexico

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CIATECH
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I. HISTORICAL OVERVIEW

Corn constitutes about 60% of the average Mexican diet. There is a serious problem of malnutrition in several states of the country.

At present, the price of a glass of milk is 4 cents ($0.04), a steak weighing 200 grams, 64 cents ($0.64), and an egg, 5 cents ($0.05). The equivalent value in proteins of full-fat soy flour (FFSF) costs 1 cent. Unfortunately, all food that has a high value in protein and a low cost, such as soybeans and oats, is used in low percentages (5%) for direct feeding of human beings. The rest is used for cattle, hog and poultry feed.

Manuel Bernardo Aguirre, our present Governor, had been worried for several years because of this situation, so he was excited when he learned about the high value in protein in the soybean and its low cost.

Therefore, in January 1977, under the supervision of CIATECH, a project was begun to industrialize soy for human consumption. From the different possibilities (extraction of oil and paste, textured, isolated protein and obtention of full-fat soy flour), Hector Acosta and Armando Camacho, engineers of CIATECH, selected the extrusion process to get full-fat soy flour for the following reasons:

1. A simple technology for processing
2. Complete obtention of proteins, calories and fat
3. An initial low investment

We learned for the first time about the Brady machine from a pamphlet of the American Society of Soy in Mexico. After this, Colorado State University encouraged us to go to Costa Rica, where with the aid of Delbert Clark we were able to see how the machine worked.

We subsequently visited Colorado State University where they demonstrated the Brady and the Insta-Pro extruders and allowed us to disassemble both machines. This experience and our evaluations of several other processes to make FFSF led us to the final decision to use the Brady for the following reasons:

A. The process using this type of extruder gave us a more economical result due to the low initial investment, less consumption of electricity, the lack of need for a steam boiler, low operational costs, smaller plant or building requirements, simplicity of operations and maintenance.

B. The knowledge that this was being used on a commercial level in other places of the world (Costa Rica and Bolivia among them).

C. The fact that the Brady is used to cook cereals (corn, among others).

II. CURRENT STATUS OF LOW-COST EXTRUSION COOKER ACTIVITIES

A. Production

1. The full-fat soy flour plant was begun in March 1978.

   PRODUCTION: 4 tons per eight hours
   CAPITAL REQUIRED: US $262,312.08

   EMPLOYEES: 12
   PRODUCT VALUE: ($/Kg) U.S. $0.51 (See Table I)

2. The soy milk and malted milk plant will begin production in February 1979 and will use full-fat soy flour as raw material.

   CAPACITY: 3,000 liters/8 hours
   CAPITAL REQUIRED: US $109,303.03

   EMPLOYEES: 13
   PRODUCT VALUE: Soy milk, U.S. $0.10; soy malted milk U.S. $0.14 (per liter)

B. Product Testing -

1. Several products have been tested with the Brady extruder besides full-fat soy flour. We have successfully tested corn in combination with soy and particularly with oats, as Chihuahua produces more than 80% of all the corn grown in the country.

2. Tables I and II report the results of proximate analyses of the FFSF and its raw material. Its microbiological and bacteriological analysis is given in Table III.

C. Marketing strategy -

As this product (FFSF) is almost new, we are introducing it in the market as follows:

Table I. Proximate Analysis of Full-Fat Soy Flour

Protein	(%)	39.13
Moisture	(%)	4.4
Ash	(%)	5.17
Fat	(%)	26.8
Fiber	(%)	3.64

Table II. Proximate Analysis of Raw Material Used for FFSF

Soybean Hull Fraction

Moisture	11.575	%
Ash	3.89	%
Ether Extract	2.63	%
Crude Fiber	42.22	%
Crude Protein	14.82	%

Raw Dehulled Soybean Fraction

Moisture	4.4	%
Ash	5.1725	%
Ether Extract	26.8	%
Crude Fiber	3.64	%
Crude Protein	39.13	%

Table III. Microbiological and Bacteriological Analysis

Sample	Total Count	Colliforms	Fungus	Yeasts	Thermophilics
1-VIII	0	0	0	0	0
2-VIII	200	0	0	0	0
3-VIII	200	1	0	0	0
4-VIII	0	0	0	0	0
5-VIII	600	0	0	0	400
7-VIII	500	0	0	0	300
31-VII	100	0	0	0	0
X	0	0	0	0	0

Observations: Numerical values correspond to the number of developed colonies per gram. A standard agar plate count was used for the total; for fungus, sabouraud; for colliforms, violet red bile and Tergiol 7.

1. At the industrial level -
   a. as a substitute for eggs in bakeries
   b. as raw material for powdered milk for children who cannot digest maternal milk or cow's milk
   c. it will be introduced as raw material in the plant which will produce soy milk

2. Commercial level (retail) flour -
   a. a wide publicity campaign over the radio and in the newspaper
   b. a course was given to ten girls so they would give demonstrations in big supermarkets, teaching how to use a book of recipes.

D. Nutrition Education - Institute Chihuahuense for the Investigation and Development of Nutrition

The Governor has just started this Institute. It's principal function will be to publicize details of better nutrition from the use of soy and oat products. (All of this work will also benefit the market for soy flour.) The following programs were established:

1. group of social workers was trained to use films, slides and other visual aids and small stoves to teach at schools all mothers with children how to use soy flour and some details concerning nutrition

2. similar program is being planned to be used throughout the state, especially in the rural communities

E. Distribution Channels

Distributors for this product have been named in Mexico City, Guadalajara, Monterrey and Chihuahua. Every distributor has been asked to have inventory space for this product. We have also sent them recipe booklets and advertising posters

F. Costs - Table IV shows FFSF cost data in U.S. $

Table IV. Costs of Producing 90 Tons of FFSF

	Total Cost		U.S.$/Kg
Production Cost			
Raw Materials[1]	$32,030.22	=	.356
Labor Costs	2,354.35	=	.026
Installation Costs	5,873.85	=	.065
Packaging	928.60	=	.010
Sub-Total	$41,187.02	=	.457
Operating Costs	$ 1,445.46	=	.016
Administrative Sales	$ 3,280.77	=	.036
Sub-Total	$ 4,726.23	=	.052
Total Cost	$45,913.25		0.509

[1] 112.5 tons of raw materials were required to produce 90 tons of finished product.

III. FUTURE PLANS

A. To design a more compact plant for production of full-fat soy flour in such a manner that production costs will be reduced.

B. To have more research work done on the roaster and compatible FFSF roasting systems with the aim of trying to reduce the cost per kilogram of full-fat soy flour. This would be for the purpose of eliminating the use of the Alpine Mill, since its operation is quite expensive due to the high consumption of energy, initial investment and maintenance.

C. We have already presented to the Governor a budget and applied for funds to start operating a plant this year. It will produce cornmeal with soy, "PINOLE", and oats with soy to solve the problem of malnutrition in the Tarahumera mountains, where there is a high incidence of tuberculosis.

D. To cover our market and expand the use of the extruder system, a project was presented to the President of Mexico in November 1978. This project involved the installation of plants to produce corn and soy flour for the making of "tortillas" (corn patties) and "atoles" (corn meal and soy mush), which are highly nourishing and have a low cost. This low cost is important in states where there is a problem of malnutrition.

Recipe books and lectures on nutrition and the use of soy flour are used in presentations.

Women are trained to demonstrate recipes.

The Philippine Program: Low-cost Extrusion Cooker (LEC) Activities

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HISTORICAL OVERVIEW

The recognition of the high prevalence of protein-calorie deficiency in the Philippines and of its serious socio-economic implications for the fugure of the country has inspired the PWU BARANGAY Technology Center (BATEK Center) to undertake research on the development of blends of high protein quality and low cost to help provide nutritious foods with which to improve the nutritional status of vulnerable groups.

The BATEK Center has been active in the development of high-protein foods for human consumption such as enriched native snacks, noodles, purees, porridge and beverages. When the Brady extruder became available to BATEK in 1977, on loan from the USDA through USAID/Philippines, two objectives were established for the study: first, to explore the potential for low-cost extrusion of indigenous materials to be utilized for pre-school and school feeding programs; and second, to transfer the technology to those interested in the process.

The low-cost extrusion cooker (LEC) is well-suited to a developing country like the Philippines, since it requires only a small amount of initial capital, technical input, and auxilliary equipment for operation. Cooking is done entirely by friction and does not need any additional heat source such as steam. However, the cooker needs large power units ranging from 50 to 100-Hp for proper operation.

The LEC can be employed to process indigenous materials such as legumes (soybean, mungbean, cowpea, etc.) in combination with cereals (rice and corn) and nuts (peanuts and coconuts). The resulting foods can then be offered for sale to various government agencies and charitable institutions on a non-profit basis for distribution to different schools and feeding centers with the intent of alleviating malnutrition.

A Brady Crop Cooker #206 (Figure 1) was installed May 9, 1977 at BATEK Center, Dasmarinas, Cavite. This is a project jointly sponsored by the Philippine Institute of Nutrition, Food Science and Technology (PWU affiliate), United States Department of Agriculture, United States Agency for International Development, and Colorado State University. A local grinder (Figure 2) was purchased for grinding cereals, legumes and nuts prior to extrusion.

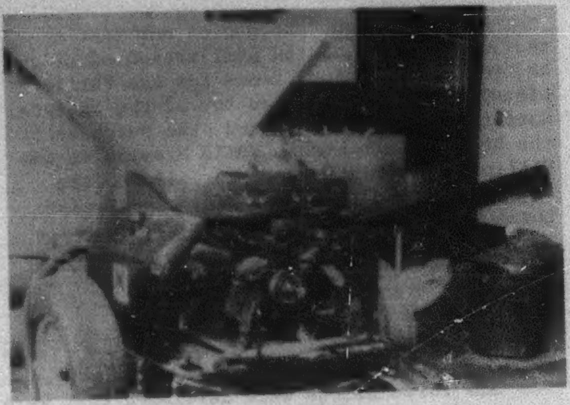

Figure 1. Brady Crop Cooker Model 206

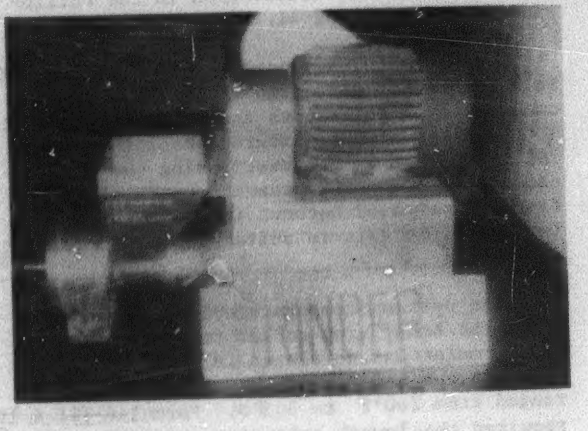

Figure 2. Mechanical Grinder (3Hp)

After a year of intensive exploration of the potential of the Brady Crop Cooker as a practical tool for combating malnutrition in the Philippines, the BATEK Center organized a workshop/seminar held on January 10, 1978. This workshop/seminar was attended by production managers from the food industry, representatives from government food research organizations, and international organizations involved in nutrition programs. Five position papers dealing with preliminary studies on the capability of LEC in the Philippines were presented. Mr. Paul Crowley of USDA/OICD attended the workshop and gave a paper on "LEC Activities Worldwide." About 100 persons attended. The workshop succeeded in popularizing the idea of using the Brady cooker for extrusion of indigenous crops in the Philippines.

Because of the success of our year's research program on the utilization of LEC to produce nutritious foods for the Philippines, the executive director of the National Nutrition Council requested the purchase of the Brady cooker by the USAID Mission in the Philippines. This arrangement allowed the BATEK Center to further explore local mixtures to be extruded.

CURRENT STATUS OF LEC ACTIVITIES

Product Formulations

Six formulations were developed that were successfully extruded through the Brady crop cooker (Table I). Indigenous materials such as rice, corn, pigeon pea (Cajanus cajan), mungbean (Phaseolus ameus Roxb.), winged bean (Psophocarpus tetragonolobus), cowpea (Vigna sinesis), peanut and coconut were considered for extrusion, since these materials are suitable for local cultivation in the Philippines (Figures 3 and 4).

For cereals, a concentration of 10 to 75% is suitable for extrusion when processed in combination with legumes and peanut or coconut. A cereal-legume-nut mixture containing 20-to-70% legume can be processed using the Brady cooker. A 10-to-40% peanut or partially defatted dessicated coconut in combination with legume and cereals is suitable for extrusion (Table I).

The optimum temperature for extrusion using the Brady crop cooker for each of the six formulations developed is shown in Table II. The optimum temperature for cooking ranged from 260°F to 365°F. Formulae III & IV required the lowest extrusion temperature (260° to 265°F) compared to Formulae I, II, V & VI. This is probably due to the high oil content of Formulae I, II, V & VI supplied by the 13% peanut or 30-to-40% partially defatted dessicated coconut present in the mixture.

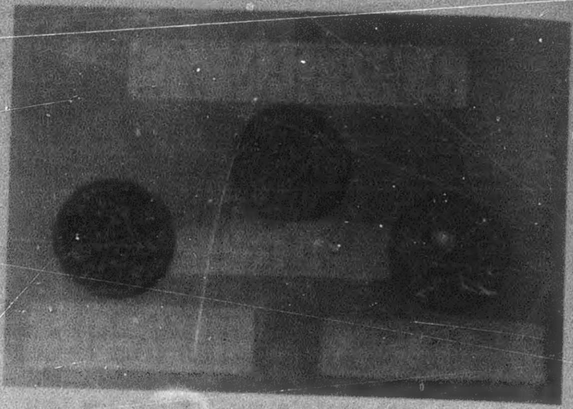

Figure 3. Pigeon pea, corn and peanut used for Formula I.

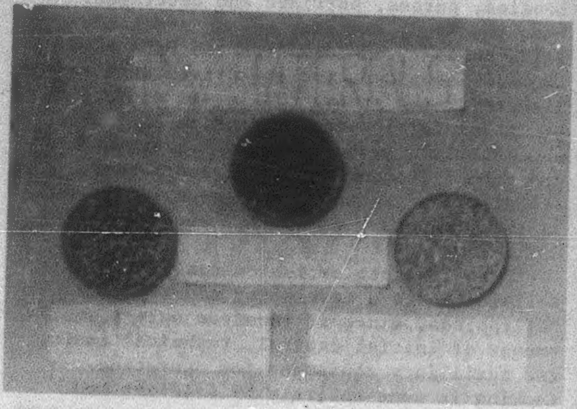

Figure 4. Mung bean, corn and peanut used for Formula II.

Nutritional Evaluation

Proximate analysis was conducted for each of the cooked blends, and results are shown in Table III. Formula III was found to have the highest protein, crude fiber and ash content. The high protein content of Formula III as compared to Formulae I, II, IV, V & VI is probably due to the high protein content of winged bean compared to mungbean, pigeon pea and coconut. The crude fiber content of the six formulations ranged from 2 to 3%. Maximum fiber levels in Title II food commodities ranged from 1.5 to 2.5% (Jansen, 1976). The tolerable level of crude fiber for adults is approximately

4 to 6% (FNRI personal communication). On the basis of tolerable crude fiber content, the six blends are considered suitable for both pre-school and school feeding programs.

Table I. Lists of Mixtures of Cereals/Legumes/Nuts Successfully Extruded by using a Brady Crop Cooker

Formula	Cereal	Legume	Nut
I	62% Corn	25% Pigeon pea	13% Peanut
II	70% Corn	20% Mungbean	10% Peanut
III	35% Corn 35% Rice	30% Winged bean	
IV	10% Corn 10% Rice	70% Cowpea	10% Coconut
V	70% Rice	-	30% Dessicated Coconut (partially defatted)
VI	60% Rice	-	40% Dessicated Coconut (partially defatted)

Table II. Extrusion Temperature

Formula	Optimum Temperature of Extrusion (°F)
I	320
II	320
III	265
IV	260
V	365
VI	365

Table III. Proximate Analysis of the Six Blends

	FORMULAE					
	I	II	III	IV	V	VI
Moisture	8.0	9.0	7.0	7.0	5.0	6.0
Protein	16.0	15.0	17.0	18.0	9.0	12.0
Fat	6.0	8.0	7.0	3.0	4.0	5.0
Ash	2.0	2.0	3.0	2.0	2.0	3.0
Crude Fiber	2.0	3.0	3.0	3.0	2.0	3.0
Carbohydrate	66.0	63.0	62.0	64.0	79.0	72.0

Table IV. Protein-Calorie Content of the Six Formulations Compared to CSM and Breast Feeding

Commodity	Kcal	Protein	Fat	Carbohydrate	% calories from Protein	% calories from Fat
CSM	373	19	6.0	62.0	20.4	14.5
Formula I	382	16	6.0	66.0	17.0	14.0
" II	384	15	8.0	63.0	15.6	19.0
" III	398	17	7.0	65.0	17.0	16.0
" IV	355	18	3.0	64.0	20.0	8.0
V	398	9	4.0	79.0	9.0	9.0
VI	381	12	5.0	72.0	12.0	11.0

To assay a more realistic nutritional impact of the extruded blend, one has to consider the calorie density of the blend and the protein-energy-ratio. Table IV shows a comparison of the percentage of calories supplied by protein and fat to that of corn soy milk (CSM) blend. The percentage of calorie supplied by fat in Formulae I, II, & III are comparable to that of CSM, while the percentage of calories supplied by protein in Formulae I, II, III & IV are quite comparable to that of CSM. In areas like the Philippines where children are consuming primarily rice with small amounts of legumes, the protein level can be safely reduced to 12% of calories if PER's are at least equal to 80% of casein and digestibility is adequate as measured by infant feeding (Jansen, 1976).

Since all six formulations except Formula V are capable of supplying at least 12% of calories, the nutritional contribution of the extruded blends in terms of protein and calorie is quite promising. However, it is imperative that PER's and digestibility studies be conducted.

To determine the quality of the protein of the blend, one has to determine the amino acid composition of each blend. Dr. G. Richard Jansen of Colorado State University is of the opinion that calculation of amino acid scores from the Food Composition Table will be sufficient to assay the amino acid composition of the blends. Table V gives the theoretical amino acid composition of each blend, and Table VI shows th amino acid scores of each blend. Tryptophan was found the most limiting amino acid in Formulae I, II, V & VI. Formulae III & IV were found to contain adequate essential amino acid based on the calculation of amino acid scores. Of the six formulations, Formula IV, consisting of a mixture of 70% cowpea (Vigna sinesia), 15% rice, 10% corn and 10% coconut, gave the highest amino acid score. This was perhaps due to the relatively higher amount of legume (70%) in the mixture compared to the legume content of the other blends (20-to-30% legume).

Recipe Development

All the six extruded blends can be marketed as a cereal snack that can be eaten from small bags. The snacks have to be deep-fat-fried and seasoned with salt and pepper prior to consumption. This process of deep-fat-frying can either be done by the use of pushcarts located on school campuses (Figure 5) or by the housewife.

Figure 5. Pushcart used for marketing LEC snacks.

Another form of marketing the extruded blend is to powder it into a flour by passing it through a pin mill grinder. The LEC flour/grit can be utilized for the preparation of a beverage, a porridge or a puree which is used for infant feeding, while bakery products and noodles can be utilized for school feeding programs (Tables VII & VIII). For the preparation of the beverage, the LEC flour is dissolved in hot water and flavored with chocolate and sugar, while in the porridge dish, the LEC grit is boiled for about 5 minutes and flavored with chocolate, milk, and sugar. Three purees, namely, chayote, sweet potato and banana puree, were fortified with the LEC flour in the ratio of 1:1, then boiled and sweetened. The LEC flour was found highly soluble in hot water. For the bakery products, the LEC flour can be utilized for the preparation of butter cookies (100 % LEC flour), buns (20% LEC flour) and pan de sal (lean doughbread, 5% LEC flour). A mixture of LEC flour and wheat flour in the ratio of 1:19 was found successful in the preparation of Chinese vermicelli and egg noodles (Figures 6, 7, 8 and 9).

Table V. Theoretical Amino Acid Composition of Formulae I, II, III, IV, V & VI

Amino Acid	FAO Std. (1973) g/16 gm N2	FORMULAE					
		I	II	III	IV	V	VI
Isoleucine	4	5.8	5.2	5.04	13.5	7.5	5.6
Leucine	7	10.5	9.6	9.3	19.5	11.0	8.3
Lysine	5.5	7.2	8.9	6.95	13	7.1	5.4
Methionine + Cysteine	3.5	3.3	3.0	3.57	8.5	5.8	4.4
Phenylalanine + Tyrosine	4	7.3	8.3	7.84	16.1	6.3	4.7
Threonine	4	5.6	5.2	4.91	10.2	5.3	4.0
Tryptophan	1	0.5	0.1	0.95	1.98	0.67	0.5
Valine	5	5.8	5.8	5.35	25.5	8.77	6.5

Table VI. Theoretical Chemical Score Composition of Formulae I, II, III, IV, V & VI

Amino Acid	FORMULAE					
	I	II	III	IV	V	VI
Isoleucine	145	130	126	337	188	140
Leucine	150	137	133	278	157	118
Lysine	236	161	126	236	129	98
Methionine + Cysteine	94	86	102	243	166	125
Phenylalanine + Tryosine	182	207	196	402	156	117
Threonine	140	130	123	255	132	100
Tryptophan	50*	10*	95	198	67*	50*
Valine	116	116	107	510	175	130

* limiting amino acid

Formula of each Recipe	Beverage	Puree	Porridge
Formulae I & II		chayote sweet potato banana	chocolate-flavored boiled LEC grits (champorado)
Formula V	chocolate drinks	squash	
Formula VI		squash	

Table VIII. Lists of Recipes for School Feeding Program

Formula of each Recipe	Snack	Noodle	Cookies	Bread
Formulae I & II	butter-flavored molded LEC flour (pulvoron)			
Formula III	butter-flavored molded LEC flour (pulvoron)	mami Chinese vermicelli	butter cookies	
Formula IV	glory curls	Chinese noodle	butter cookies	
Formula V	butter-flavored molded LEC flour (pulvoron)	Chinese noodle	butter cookies	
Formula VI	chippy		butter cookies	nutribun pan de sal

Figure 6. Snacks made out of LEC flour.

Figure 7. Glory curls made out of LEC flour.

100%
COCORIZ
Baby Food

igure 8. Baby foods made out of 100% LEC flour.

Acceptability Test

A total of twenty (20) recipes were developed and subjected to organoleptic evaluation. The recipes intended for pre-school feeding were evaluated by mothers of malnourished children. As shown in Table IX, the mothers showed highest preference for banana puree, compared to sweet potato and chayote puree. Out of 20 mothers, 85% graded the banana puree as "liked very much," compared to 70% for the sweet potato and 50% for the chayote puree. However, no mothers graded the banana puree as "disliked," while 10 and 25% of the mothers rated as "disliked" the sweet potato and chayote puree, respectively.

Table IX. Results of Acceptability Test For Infant Group (Formula I and Formule II)

Formulation	Liked Very Much	Moderately Liked	Disliked
1. Banana puree	17	3	0
2. Sweet potato puree	14	4	2
3. Chayote puree	12	3	5

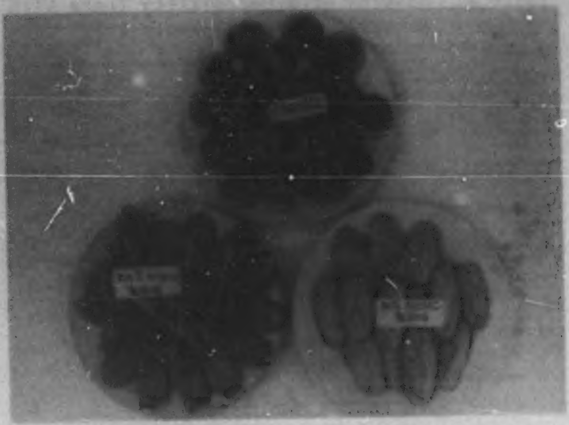

Figure 9. Butter cookies made out of 100% LEC flour.

Acceptability tests for snacks, noodles and bakery products intended for school feeding programs were conducted on a total of one hundred eighty-nine (189) school children. The results are shown in Table X. Fritters obtained the highest preference due to their crispness and seasoned flavor, while glory curls rated second. Butter cookies were rated least acceptable (Figure 10).

Figure 10. Acceptability test conducted with school children for LEC products.

A list of the most acceptable recipes using LEC flour is shown in Table XI. A total of 13 recipes were developed and found acceptable when field-tested with malnourished preschoolers and school children in six elementary schools. All recipes are given in Appendices I to VIII.

Table X. Results of Acceptability Tests With School Children (Formula III)

Formulation	Extremely delicious	Delicious	Not delicious
1. fritters	40	0	0
2. glory curls	17	7	0
3. noodle (Chinese vermicelli	2	27	0
4. butter-flavored molded LEC flour	1	21	6
5. cookies	2	20	6

Pre-Pilot Plant Cost Estimate

So far, our experiments on the processing of LEC snack/flour/grits were conducted on a batch-type laboratory scale. Only short runs (2 hrs/run) were evaluated. It is not possible at this stage with the data and information on hand to determine with acceptable accuracy the cost of processing the LEC products. The pilot plant is needed to gather the pertinent economic data needed for the determination of exact unit costs.

Despite the insufficiency of data, very preliminary cost estimates were calculated. Using these estimates, we feel that the LEC products will be very competitive with existing snacks on the market. Our preliminary estimates show that the present retail prices of snacks like chippy, cheese curls, pretzels, etc., are 5-to-10-times more than the cost of manufacturing LEC snacks. We therefore feel that the LEC products will be economically viable.

FUTURE PLANS

In August 1978 Red V Coconut Products, Ltd. and the Philippine Women's University/Philippine Institute of Nutrition, Food Science and Technology, agreed to conduct R & D work on coconut food products. The initial efforts were centered on coconut-corn or rice blends using the Brady extruder installed at the BATEK Center.

After testing several formulations using coconut meat in combination with either rice or corn, a RICOCO blend (60% rice plus 40% dessicated coconut) was found technically feasible on a laboratory scale. Because of the encouraging results obtained, the PWU/PINFST and Red V will jointly undertake a pilot plant study on the production of RICOCO snack flour/grit on a pilot plant scale. The pilot plant study will have the following objectives:

A. To verify on extended runs the findings of short-run (1 hr. or so) trials of extrusion cooking using the Brady cooker.

B. To produce sufficient quantitites of RICOCO for test-marketing and test-processing into food products like RICOPEK, RICOCO cookies, RICOCO nutribuns, COCORIZ flour, etc.

C. To correct operating bugs encountered during the pilot plan operations.

D. To secure design data for the projected commercial-scale RICOCO plant.

E. To secure economic data for forecasting its economic viability.

F. To prepare technical bulletins on RICOCO and its uses.

The material and flow diagram are shown in Figure 11.

Table XI. List of Most Acceptable Recipes Using Extruded Blends

Formulations I & II	III	IV	V & VI
1. banana puree	1. fritters	1. Chinese noodle	1. butter cookies
2. chocolate-flavored glutenous rice porridge (champorado)	2. glory curls	2. glory curls	2. chippy
3. butter-flavored molded LEC flour (pulvoron)	3. Chinese vermicelli		3. sweetened puree
			4. nutribun
			5. squash puree

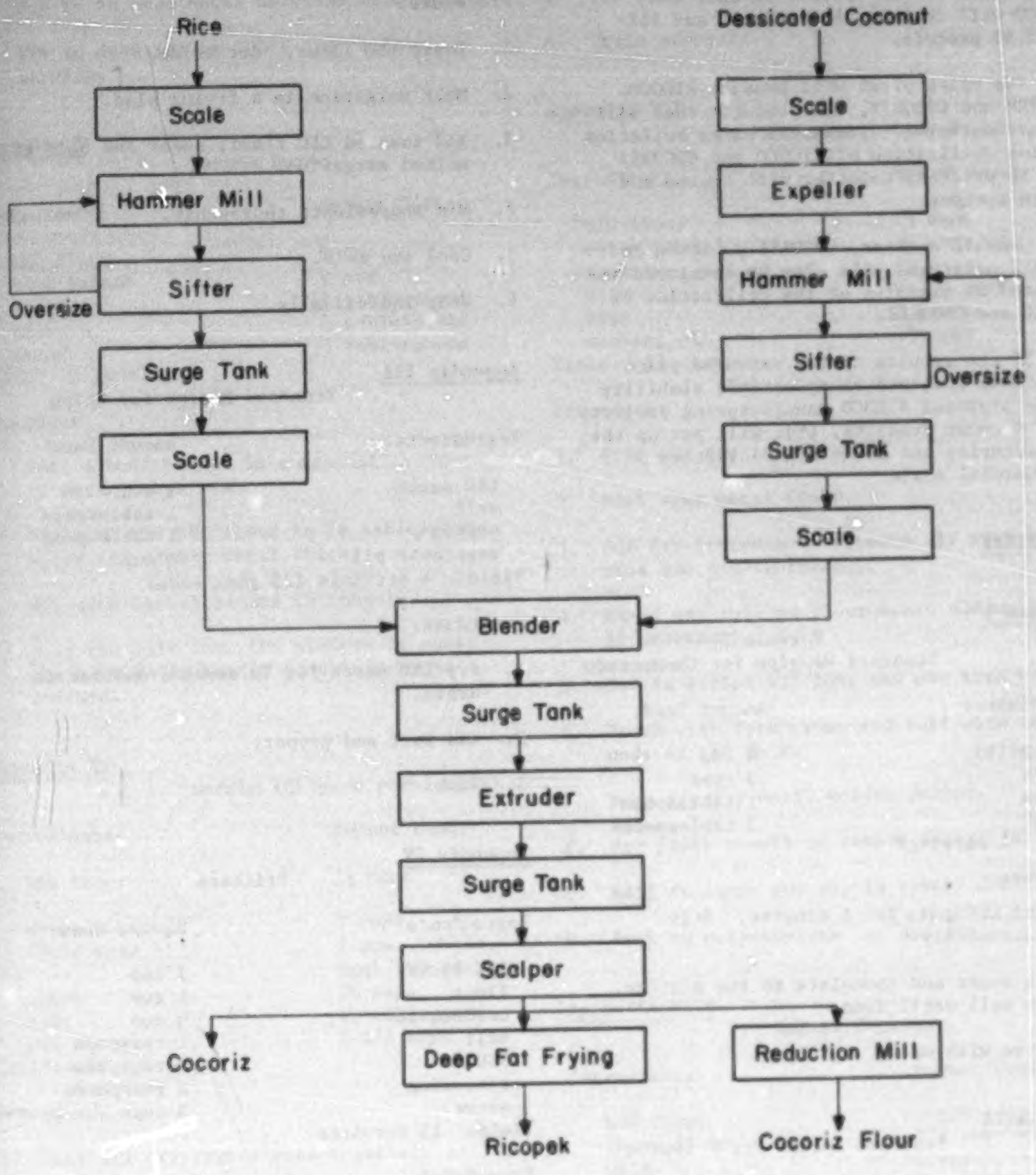
Rice
Scale
Hammer Mill
Sifter
Oversize
Surge Tank
Scale
Dessicated Coconut
Scale
Expeller
Hammer Mill
Sifter
Oversize
Surge Tank
Scale
Blender
Surge Tank
Extruder
Surge Tank
Scalper
Cocoriz
Deep Fat Frying
Ricopek
Reduction Mill
Cocoriz Flour

Figure 11. Flow diagram of the production system for RICOCO snack flour/grit.

The estimated capacity of the RICOCO pilot plant is 600 kgs. of RICOCO per shift of eight hours. This will require 480 kgs of rice flour and 320 kgs of coconut meal. The coconut meal will contain 25%-to-30% oil and 18%-to-20% protein so that the RICOCO will contain 3%-to-4% oil and 11%-to-12.5% protein.

The pilot plant will produce RICOCO, RICOPEK and COCORIZ, the products that will be test-marketed. Technical sales bulletins showing utilization of RICOCO and COCORIZ will be written, together with tested and proven recipes.

CORORIZ cookies, COCORIZ pulvoron and COCORIZ nutribuns will also be developed and produced as examples of the utilization of RICOCO and COCORIZ.

If the results of the extended pilot plant runs indicate an acceptable viability of the proposed RICOCO manufacturing project, Red V Coconut Products, Ltd. will put up the manufacturing and marketing facilities on a commercial scale.

APPENDICES

Appendix I

Formula I
Standard Receipe for Champorado

Ingredients:	Amount Used:
LEC grits	¼ cup
water	3 cups
cocoa	1 tablespoon
sugar	3 tablespoons

Yield: 4 servings

Procedure:

1. Boil LEC grits for 5 minutes. Stir continuously.
2. Mix sugar and chocolate to the mixture. Mix well until done.
3. Serve with milk.

Appendix II

Standard Recipe for Pulvoron

Ingredients:	Amount Used:
LEC flour	¼ cup
margarine	2 teaspoons
sugar	10 tablespoons

Yield: 30 pieces at 3 pieces per serving = 10 servings

APPENDICES (continued)

Appendix II (Cont'd)

Procedure:

1. Toast LEC flour. Set aside.
2. Melt margarine in a frying plan.
3. Add toasted LEC flour, sugar and salt to melted margarine.
4. Mix ingredients thoroughly.
5. Cool and mold.
6. Wrap individually.

Appendix III

Standard Recipe for Chips

Ingredients:	Amount Used:
LEC snack	¼ cup
salt	1 tablespoon
pepper	1 tablespoon
vegetable oil	½ cup

Yield: 4 servings (25 gms. each)

Procedure:

1. Fry LEC snack for 20 seconds and let it drain.
2. Add salt and pepper.
3. Pack.

Appendix IV

Fritters

Ingredients	Amount Used:
LEC flour	1 cup
flour	1 cup
cornstarch	½ cup
salt	1 teaspoon
MSG	2 teaspoons
seasoning	2 teaspoons
water	3 cups

Yield: 15 servings

Procedure:

1. Mix the ingredients thoroughly.
2. Pour the mixture into an aluminum pan.
3. Steam for at least 2 minutes.
4. Cut into 1" x 2" pieces.

APPENDICES (Continued)

Appendix IV (Cont'd)

5. Dry in an oven until hard and translucent.

6. Fry in deep fat at 400°F just before serving.

Appendix V

Banana Puree

Ingredients:	Amount Used:
LEC flour	½ cup
ripe banana	½ cup
water	16 tablespoons
milk	3 tablespoons
sugar	3 tablespoons

Yield: 2 servings

Procedure:

1. Peel & boil banana in a minimal amount of water, then mash.

2. Dissolve the LEC flour in 16 tablespoons water and simmer until thick.

3. Mix with mashed banana thoroughly.

4. Pour the milk into the mixture or shake the mixture in bottle to obtain finer texture.

Appendix VI

Noodle (Chinese vermicelli)

Ingredients:	Amount Used:
LEC flour	2½ cups
wheat flour	3 cups
whole eggs	2 pcs. (whole egg) 100 gms.
water	2½ cups
salt	1½ tablespoon
oil	1-3/4 cups

Yield: 75 servings

Procedure:

1. Sift all dry ingredients together.

2. Dissolve salt in water.

3. Add whole eggs and water to dry ingredients.

4. Incorporate dry and liquid ingredients to form a dough to approximately 1/8" thick and cut into strips of desired width.

APPENDICES (Continued)

Appendix VI (Cont'd)

5. Pre-cook noodles in boiling water with oil.

6. Drain properly.

Appendix VII

Galorias (Glory Curls)

Ingredients:	Amount Used:
LEC flour	1½ cups
wheat flour	2½ cups
sugar	1½ cups
milk	3-1/4 cups
eggs	3 pieces
cooking oil	1½ cups

Yield: 12 servings

Procedure:

1. Sift all dry ingredients.

2. Beat eggs until foamy.

3. Add dry ingredients alternately with the milk and mix thoroughly.

4. Knead and roll on flour board adding flour if necessary.

5. Cut in strips 1½" long and one inch wide.

6. Press with fork tines and roll with the ends of the fork.

7. Deep fat-fry until golden yellow.

8. Use paper towels to remove excess fat.

9. Roll in sugar and dip in syrup. Cool.

10. Pack in polyethylene bag and seal.

Appendix VIII

Butter Cookies

Ingredients:	Amount Used:
LEC flour	1-3/4 cups
wheat flour	3/4 cup
milk	½ cup
margarine	2 teaspoons
sugar	3/4 cup
eggs	5 whole eggs

Yield: 12 servings

Appendix VIII (Cont'd)

Procedure:

1. Cream the margarine until soft and fluffy.
2. Add sugar, then the eggs.
3. When all of these ingredients are well-blended, add wheat and LEC flour, blend alternately with the milk.
4. Blend well.
5. Drop on cookie sheet, one teaspoonful each.
6. Bake at 350°F.

Appendix IX

Nutribun

Ingredients:	Amount Used:
Wheat flour	500 gms.
LEC flour	250 gms.
yeast	10 gms.
sugar	60 gms.
yeast food	2.5 gms.
salt	10 gms.
shortening	50 gms.
milk	35 gms.
water	425 gms.

Yield: 18 pieces

Procedure:

1. Mix all dry ingredients.
2. Add water and mix thoroughly to form a dough.
3. Ferment for 3 hours.
4. Mix again and cut into pieces at least 50 grams per piece.
5. Let it rest for 20 minutes.
6. Bake at 350°F.

Appendix X

Pan de sal

Ingredients:	Amount Used:
Wheat flour	500 gms.
LEC flour	250 gms.
yeast	10 gms.
sugar	60 gms.
yeast food	2.5 gms.
salt	10 gms.
shortening	50 gms.
milk	35 gms.
water	425 gms.

Appendix X (Cont'd)

Yield: 60 pieces

Procedure:

1. Mix all dry ingredients.
2. Add water and mix thoroughly to form a dough.
3. Ferment for 3 hours.
4. Mix again and cut longitudinally to form a long stick-like shape about 1½" thick.
5. Cut into pieces at least 30 gms. each.
6. Let it rest for 20 minutes.
7. Bake at 350°F.

Appendix XI

Chocolate Beverage

Ingredients:	Amount Used:
water	1 cup
cocoa	2 tablespoons
LEC flour	2 teaspoons
sugar	2 teaspoons
milk	¼ cup

Yield: 1 serving

Procedure:

1. Dissolve cocoa and LEC flour in hot/cold water.
2. Add sugar and milk.
3. Mix thoroughly.

Panel Presentation: Characteristics of LEC's and Manufacturing Experiences

Wayne Fox
Triple "F" Company
Des Moines, Iowa

It is a real pleasure to be here in Tanzania to see our many friends from around the world and to discuss a subject of common interest to all of us--one that can play a vital role for humanity in the years ahead. Unfortunately, there is so much to be discussed and so little time to do it, we must condense our remarks here today.

Others, including Mr. Paul Crowley, have given you extensive background on the development of low-cost extruders and work that has been done adapting those extruders to supplying food supplements to developing countries. I will try to briefly tell you about Triple "F's" experiences and recent developments.

As most of you know, Triple "F" became interested in developing a piece of low-cost, safe, economical equipment for the processing of whole soybeans fifteen years ago. After building approximately five different units to "roast" soybeans and doing extensive research as to their nutritional and economic value, in January of 1969 we came up with the idea of the "dry" extruder, where the heat to process the beans was created strictly from pressure and friction with no need for additional energy. Our testing with livestock proved this method more economical and safer than the roasting methods.

After the first machine, powered by the P.T.O. (power take-off) shaft of a tractor, was hand-built and the feasibility of the idea was confirmed, we had the Wenger Manufacturing Company of Sabetha, Kansas build us a pilot model. The first unit never left the Wenger plant, because after it ran for thirty minutes it was obvious that many modifications were needed.

After we redesigned the equipment, two more units were built. One was placed in a machine shop on our farm just west of Des Moines, Iowa, and was powered by a 100-hp Perkins 6-cyl. 354-cu. in. diesel engine. During the spring and summer of 1969 approximately 1400 tons of soybeans were extruded through this unit, and approximately 50 design changes were made to it. We then had Wenger build five more units, and these were placed in our own feed manufacturing plants in September and October of 1969.

After incorporating the design changes, we then had Wenger build another 50 units, and later on, another 50. The first 105 units built were powered by 75-hp or 56-kW electric motors, and that size unit of the Insta-Pro extruder is now referred to as the Model 2000.

In 1970-71 we felt a need for a smaller piece of equipment, and we designed the Insta-Pro Model 500, which was driven by a 50-hp or 37.5-kW electric motor. Approximately 300 of these units have been manufactured and sold since 1972. Upheavals and adverse economic developments relating to the use of "full-energy soybeans" (cooked whole soybeans) in relationship to regular soybean meal in 1970-71 made us turn our attention to the use of the Insta-Pro extruder for other purposes. In 1972 we developed and patented a process called "Golden Pro,"[1] which was a substitute protein supplement for ruminant animals to replace natural protein at a cost of approximately one-eighth the per-unit price of protein. In 1975 and 1976, 120 units were sold to the U.S.S.R. for the purpose of building 20 plants of 6 extruders each. It is our understanding that the U.S.S.R. has now copied the machine and has built approximately 1,000 more units, and that "Golden Pro" is the standard protein supplement used for dairy and beef animals all over the the Soviet Union.

Further reasearch has led us to the use of the Insta-Pro extruder for manufacturing such other items as corn-soy mixtures for use in baby pig starters, complete starters for both swine and calves, pet foods (for which there is a 3-billion-dollar-per-year market in the U.S.A. alone), extruded trout and catfish foods and, lately, fresh-water prawn food. We have quotes out right now to Thailand, South Africa, Hawaii and others for prawn food plants.

We are continuing our research on such things as food for laboratory animals, rodent baits, detoxifying rice bran, reclamation of waste products such as poultry waste, sterilizing the aflatoxin in cottonseed meal, whole cottonseed and linted cottonseed, and many other uses.

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[1] Registered trademark.

The newest development in the livestock industry recently is the discovery of the benefits for dairy cattle and young beef cattle of a low-soluble, highly-non-degradable natural protein for use in the production of milk and beef. Time does not permit an explanation of this now, but we have sold 10 or 15 Model 2000 Insta-Pro extruders in December and January for this product alone. These machines have gone to Germany, England, Ireland, Mexico, France, South Africa, Malasia and others. We are working with the American Soybean Association, the Universities of Washington, Wisconsin, Illinois and Massachusetts and Purdue U. on current research projects.

Seeing Dr. Siegel here reminds me of a new development in the soybean program--one which could have a far-reaching effect on the LEC program. Someone in the eastern United States--Georgia, I think--has come up with a new variety of soybeans that has a protein content of approximately 44-45% in its natural state, rather than the 38-39% now prevalent. The regular soybean industry, as it is now structured, is based on the amount of oil content of the bean and not on the protein content; consequently, there is no real interest in promoting the development of a high-protein variety. We at Triple "F", however, are very fascinated by the prospect of increasing the protein content of soyabeans by 15-20%, since we feel that it is of great economic advantage in our purpose of helping to alleviate protein deficiency in LDC's. Because of this we are endeavoring to secure some of this seed and shall go into a seed-growing program to greatly increase the production of this seed for use in the programs using LEC's.

We are also working with the University of Washington on the processing of surplus peas and various varieties of beans.

I should mention as a point of interest the newest concept for the use of the Insta-Pro extruder. At the present time, there is a great deal of discussion world-wide and particularly in the U.S.A. about energy, or lack thereof. One of the solutions proposed is the use of carbohydrate materials for the production of alcohol to use to extend the supply of gasoline and fuel oil. For the time being, the amount of energy expended to produce alcohol makes it impractical on an economic basis; however, Brazil, for example, has the goal of having 10% of its fuel supplied from alcohol made from sugar cane in the very near future.

A Ph.D. and bio-chemist from Minnesota claims that with the use of the dry extrusion system he can reduce the time required to make alcohol by 75% and the cost by 60-75%. If he is correct, it might be possible to produce alcohol cheaper than is presently the case in the U.S., and it certainly would be far less than the cost in such countries as Japan, France, or England.

We have left the research and development on human food products pretty much to Colorado State University and, unfortunately, they have been so busy with projects in Costa Rica, Tanzania, Guyana, Sri Lanka and others that they have had very little time to devote to researching products produced on the Insta-Pro extruder. Most of the original work has been done with the Brady, because it was easier to operate and has a larger capactiy than the original Model 500 Insta-Pro extruder which Colorado State University has.

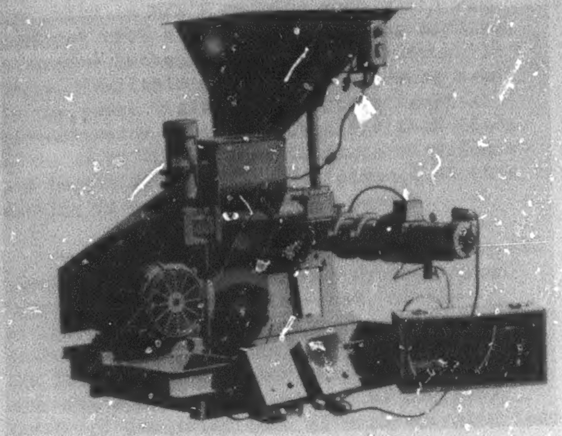
We have made extensive improvements on and modifications to the Model 2000 Insta-Pro extruder which have increased its capacity, its flexibility and its ease of operation. For example, we have made new single-flight screws which reduce the shearing action in the machine and make it much smoother-running on high-starch ingredients such as wheat and corn. We are now able to produce straight extruded cornmeal, which was impossible with the old double-flight screws. We have redesigned the volumetric feeder with a larger motor and have doubled the screw size feeding the extruder. We have changed the head of the machine so there are now options available to make configured products, and we have built within the last 60 days a new type of cutter--variable speed and three times as powerful--to handle the high-starch, configured products.

I'm sorry that space did not permit me to bring each of you samples of the various products which we make. I do have a few samples with me which you may examine, however, and if you would like a sample sent to you, give me your request and I'll mail them to you soon after my return to the U.S.A. on February 1.

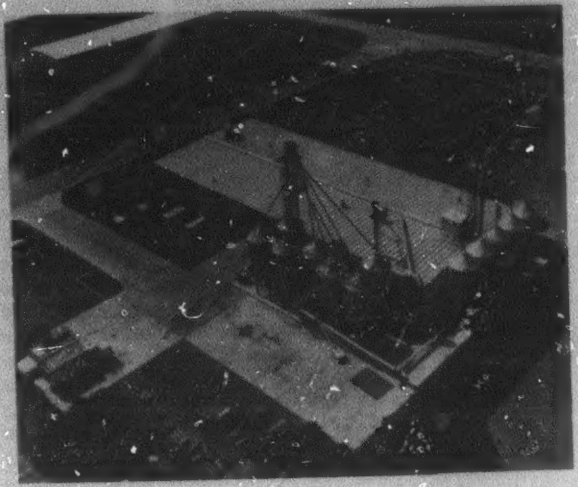
In 1978 we completed a new pilot plant in Des Moines for research and production of experimental products. We have installed grinding and milling equipment, four Model 2000 and one Model 500 Insta-Pro extruders, cooling equipment, fat-spraying equipment, vitamin-and flavor-dusting equipment and packaging equipment. We now produce approximately 20-25 tons of various products per 10-hour day in the facility, and I personally invite each of you to visit us at the first opportunity you have.

I have with me new brochures showing the new configuration of the Insta-Pro extruders and allied accessory equipment. If anyone does not get one, please let me know, and I will mail you one immediately upon my return to Des Moines.

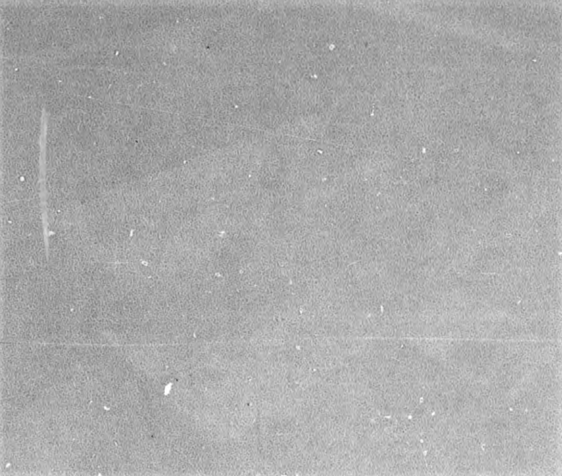
If you have any questions, please ask me personally during our next few days together.



The InstaPro Model 2000 extruder.



The Triple "F" plant in Des Moines, Iowa, USA.



Panel Presentation: Characteristics of LEC's and Manufacturing Experiences

Hank Sterner
Appropriate Engineering and Manufacturing Co.
Corona, California

During 1975, while on the staff of Meals for Millions Foundation (MFM), I was assigned to develop a low-cost extruder cooker for the production of structured vegetable protein (SVP). Other imposed design objectives were that the machine could be manufactured and repaired in developing countries. The first was built in MFM'S machine shop which was equipped with a Bridgeport milling machine, an engine lathe, and a welder. Automobile parts, available the world over, were used in the power train. The first attempt at dissemination of this technology took place in Korea at the Korean Institute of Science and Technology (KIST). Performance of this machine is reported in other papers.

During 1977, Appropriate Engineering and Manufacturing Company (AEMC) was organized to continue designing low-cost, simply-manufactured food processing machinery useful in developing countries. It was here that the 303 extrusion cooker was developed. This unit was specifically engineered for less developed countries (LDC's) with emerging food industries. Unlike the MFM model, the drive system employed in the 303 model is a high-torque timing belt and gear pulleys. This advanced design allows 95% power efficiency and a more compact and easy-to-clean machine. The size of the 303 extrusion cooker is such that it is excellent as a research tool in the developed countries and as a production unit in LDC's where SVP and extrusion cooker products are being introduced.

Appropriate Engineering's first model 303 extrusion cooker was installed in the Dominican Republic. Structured vegetable protein and snack food from corn, soy and oats have been produced on a pilot basis and are being evaluated for the market place.

Two more 303 extrusion cookers are under construction, one for commerical operation in Madera, California to produce a corn-based snack food. The second unit will be placed by Appropriate Engineering in a testing facility for further research and will be available for demonstration.

Only limited information has been obtained that relates to the production capabilities of the 303 extrusion cooker. Considering the material being processed and the product desired, one can expect outputs on the order of 68 to 136 kilograms per hour. SVP has been produced at the rate of 110 kilograms per hour at about 40% of power demand on its 30-horsepower electric motor. Our SVP screw is designed to solve the problem of operation instability by controlling free vapor which tends to interfere with the in-feeding of material and surge through the outlet dies. This control is made possible by the use of double, alternately-interrupted flights and a L/D ratio of fourteen to one. This SVP screw design reduces horsepower consumption per pound of product when compared to machines employing steam locks. Appropriate Engineering's screw fabrication is accomplished by wrapping and welding rectangular, stainless steel around standard 2-inch schedule 40 stainless steel pipe. This simplified method of fabrication eliminates the need for special milling equipment and significantly lowers the cost.

The motor power is transmitted to the screw through a high-torque drive belt. Unlike flat and V-belts, the belt does not rely on friction for pulling power. Slack-side tension is practically eliminated and tight-side tension is reduced. As a result, bearing life is prolonged. Belt sprockets used for drive reduction are selected on the ratio of four to one, resulting in a screw speed of 430 revolutions per minute from a 1750 RPM motor.

By a selection switch the extruder main drive is interlocked with other drives and switches to avoid inadvertent adverse start-up and shut-down procedures. For instance, the extruder screw power must be on before the water and infeed material will flow in. Likewise, the water will shut off if the infeed screw is shut down.

Three devices for feeding material to the extruder's main screw are available:

1. Declining force feed which employs a variable-speed flight rotating about a stationary shaft. This insures product movement to force feed material to extruder screw. The feed bin is self-emptying and does not aerate the materials.

2. Inclining feed with floor-height bin employs a variable speed feeder that conveys material to the extruder from a low-level bin which is easy to

manually load. Both declining and inclining feeders are powered by a one-horsepower DC motor.

3. An inexpensive vibrator feeder which feeds free-flowing material with unsurpassed linear control.

Water is added to the incoming dry mix material through a water line equipped with a pressure regulating valve and flowmeter which terminates at a special water injection valve located in the extruder barrel.

The extruder is equipped with interchangeable stainless steel barrel segments which contain removable splines. These features extend the useful life of the barrel. Segmented barrels are easy to assemble and disassemble, allowing fast change-over between runs and facilitating cleaning. As an option, jackets are available for both straight-and spiral-splined barrels.

The cut-off is driven by a one-HP/DC motor. The cutter swings easily into position once the desired product is established, and blade clearance can be adjusted during operation. This design assures sharp, accurate cutting for excellent product uniformity throughout the run.

A die plate with inserts is available for the discharge end of the barrel. However, to further lower costs, we provide a die plate without inserts. Instead, the plate has a single-or multiple-hole pattern, depending on material to be processed and the size and shape of desired product.

The 303 extrusion cooker frame is enclosed with an easy-to-clean 304 stainless steel shroud which has no surfaces where product and water accumulate. Maintenance is relatively inexpensive, since worn or damaged parts can be replaced locally rather than imported. All bearings should be greased every 400 hours. Worn screw and barrel parts should be replaced when product quality is not easy to maintain or production rate drops. No definitive wear-rate data are available.

The 303 extrusion cooker is flexible yet simple in design, which broadens the extruder's capabilities to match the imagination of the manufacturer to produce such products as those shown in Table I.

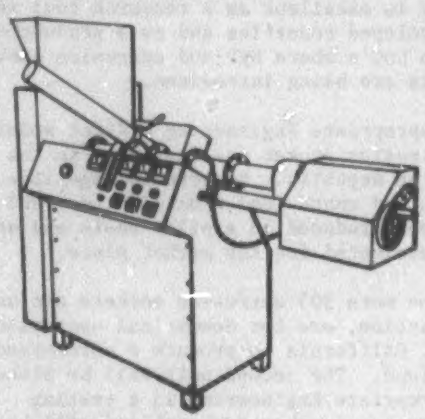
Table I. 303 Extrusion Cooker Products

Cereals	Fish Foods
SVP (structured vegetable protein)*	Pet Foods
Baby Foods	Soup
Breads	Snack Foods

*We believe the 303 extrusion cooker is the least expensive machine capable of producing SVP. Several optional features are available to meet the needs of the purchaser or manufacturer.

Appropriate Engineering has built an experimental direct-drive, high-speed extruder cooker. Significant further savings in manufacturing have been achieved. AEMC has plans to engineer a pre-conditioner to fit the 303 unit. Prior experience while conducting tests on extruders with pre-conditioners has shown at least three advantages: (1) less destruction of added colors and flavors added to infeed materials; (2) greater gelatinization of starches in materials containing high fat; and (3) less extruder screw power-demand and wear, resulting in greater product capabilities and quality. Appropriate Engineering is now evaluating conditioner designs.

Brochures are available describing the 303 extrusion cooker. Price quotations and assistance in selecting options are also available from Appropriate Engineering and Manufacturing Company.



AEMC's Model 303 extrusion cooker with feeder and cut-off.

Panel Presentation: Characteristics of LEC's and Manufacturing Experiences

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INTRODUCTION

The primary purpose of Colorado State University's role in the LEC program has been to test and evaluate the capabilities and limitations of LEC's. A large portion of the tests documenting the machines' capabilities was completed during the initial phase of the project. The scope of the project has evolved with time and now incorporates applications of the LEC technology in addition to the evaluation program.

The major activities of the LEC project by CSU are given below.

EVALUATION OF LEC's

CSU has been testing two extruders which are classified in the low-cost category. The extruders are:

1. Brady Crop Cooker, Koehring Farm Division, Appleton, WI.
2. Insta-Pro Extruder, Triple "F" Feeds, Des Moines, IA.

Koehring manufactures the Brady in two models: 1) the Model 206, which is a portable unit and powered from an ancillary power source, usually a diesel engine; and 2) the Model 2160, which is an electric-powered stationary unit. Both models have a throughput of approximately 450 kg/hr.

Triple "F" also manufactures two models of the Insta-Pro machine: 1) the Model 500, which is electrically powered with a throughput of approximately 225 kg/hr, and 2) the Model 2000, which is also electrically powered but with a larger diameter. The throughput of the Model 2000 is approximately 450 kg/hr.

CSU's laboratory consists of equipment which is portable to allow any type of convenient arrangement for manufacturing foods. They are:

1. Insta-Pro, Model 500, diesel engine-powered
2. Brady, Model 206 diesel engine-powered
3. Proportioner mill, Modern Mill, Model 600
4. Reduction mill
    a. Fitzpatrick Model D comminuter
    b. Sturtevant pin mill
5. Blender--Falcon ribbon blender
6. Dehulling equipment
    a. Sturtevant scourer-aspirator #3
    b. Cracking mill

CSB STUDY

One of the largest studies to date dealt with the ability of a LEC to manufacture a product which would meet or exceed the ASCA specifications for Title II foods. Studies have been made with corn and soybeans to develop the:

1. Methods of manufacture
2. Types of preprocessing required
3. Types of postprocessing

to manufacture corn-soybean blend (CSB).

In addition, products manufactured were analyzed for:

1. Proximate analysis
2. PER
3. Storage
4. Organoleptic tests
5. Bacteriological tests
6. Functional tests

At the last workshop, a study which surveyed the possibilities of manufacturing CSB by cooking the ingredients together or separately and followed by blending was reported. The results indicated that cooking the ingredients separately had no distinct advantage over cooking them together. Therefore, it was concluded that to manufacture CSB, the major ingredients should be blended together prior to extrusion.

Shortly after the first workshop, a second test was designed which would give additional information on the processing and preprocessing. The test consisted of extrusion at different temperatures of combinations of 70% whole corn/30% whole soybean, 70% whole corn/30% dehulled soybean, and 70% dehulled corn/30% dehulled soybean. The test was designed to determine how differing fiber levels affected the product. The fiber content can be reduced by removing some of the fibrous seed coating of corn and soybean prior to extrusion. The three formulas tested represent differing fiber contents, giving a good spectrum of products.

Nutritional results on products made during these tests are given in Dr. Jansen's workshop presentation. Manufacturing information as measured in the laboratory is given in Table I. Data showed that specific energy for both extruders was not affected significantly by removal of hulls; however, due to the abrasive nature of the seed hulls, it is expected that the extruder components, susceptible to wear, will last longer.

COTTONSEED

Low-cost extrusion cookers have proven to be quite effective for heat-treating soybeans and destroying the naturally-occurring antinutritional factors. In addition, reports are available on the effect of using a LEC to bind the gossypol in cottonseed and also to manufacture corn/cottonseed products. A study was done on cereal/cottonseed products with the following objectives:

1. Determine the LEC's capabilities to process nutritious foods from cereal and cottonseed blends.
2. Determine the most suitable cereal/cottonseed composition and corresponding processing conditions required.
3. Determine the effect of processing on the binding of gossypol.

Test data are given in Table II for combinations of both glanded and glandless cottonseed with 60, 70, and 80% cereal. Selection of these percentages was based on proximate analysis of the raw materials and the objectives to provide 15-20% protein in the extruded product. Although three temperatures were tested, Table II gives only the most practical extrusion temperature for each machine.

Both the Brady and Insta-Pro machines could extrude all ingredient combinations successfully; however, the Brady extruded blends at higher temperatures than the Insta-Pro.

Tests with the Insta-Pro indicated that the oil percentage in the blend with 60% cereal approached an upper limit. All possible configurations were tried with the largest steam locks (screw restrictions); however, the greatest success was achieved when the single-orifice die was used and the adjustable orifice tightened down, so that large back pressures occurred at the discharge of the extruder. Changing of the cereal type did not have a large effect on the operation of either extruder.

OTHER STUDIES

Other studies on the low-cost extrusion cookers are summarized in Tables III-IV.

Table III gives operational data from a vitamin retention study. Whole corn/whole soy, whole corn/dehulled soy, and dehulled corn/dehulled soy combinations were extruded with vitamins which were added to either the raw ingredients or blended into the corn/soy mixture in a batch process. The two methods were compared, and results indicated that some vitamins were destroyed during the extrusion process. In most instances, the addition of vitamins to the corn/soy mixtures prior to extrusion resulted in higher extrusion energy requirements.

A study on how the uncooked viscosity (cold water gruel) of the extrudate might be reduced by changing processing conditions was conducted. Corn and sorghum were combined equally with 5% soybean and extruded with added and without added water. Test data are given in Table IV. Energy remained relatively constant for all samples, and results indicated that the viscosity was not altered significantly.

Table V summarizes data using chickpea blends made at CSU. These samples were made for Dr. Shah of Pakistan for his evaluation prior to receiving a LEC. Results indicated that chickpeas combined with different cereals made an excellent product. Low throughputs were recorded due to the greater difficulty of extruding this oil-free formula.

Table VI gives data on extrusion of cassava and potatoes combined with dehulled soybeans.

ABLE I CSB Data

Test Parameter	Percent Cereal: 70% Whole Corn, Insta-Pro	70% Whole Corn, Brady	70% Dehulled Corn, Insta-Pro	70% Dehulled Corn, Brady
A. Dehulled Soybean/Cereal				
1. Average Feed Rate, kg/hr	162.8	342	163.6	375
2. Average Water Added, kg/hr	6.8	0	13.6	0
3. Temperature Cooked, °C	154	169	154	171
4. Power, kW	11.5	27.8	11.9	30.3
5. Specific Energy, kWh/kg	0.071	0.082	0.073	0.081
B. Whole Soybean/Cereal				
1. Average Feed Rate, kg/hr	157.9	365		
2. Average Water Added, kg/hr	7.9	0		
3. Temperature Cooked, °C	154	171		
4. Power, kW	12.3	30.8		
5. Specific Energy, kWh/kg	0.078	0.084		

TABLE II - Cottonseed Extrusion

Test Parameter	PERCENT CEREAL: 60%, Insta-Pro	60%, Brady	70%, Insta-Pro	70%, Brady	80%, Insta-Pro	80%, Brady
1. CORN/GLANDLESS COTTONSEED						
A. Average Feed Rate, kg/hr	168	216	144	312	150	252
B. Average Water Added, kg/hr	0	0	0	0	6.3	0
C. Temperature Cooked, °C	147	152	149	171	151	171
D. Power, kW	11.2	20.6	11.3	38.7	15.6	32.6
E. Specific Energy, kWh/kg	0.058	0.095	0.079	0.124	0.104	0.129
2. SORGHUM/GLANDLESS COTTONSEED						
A. Average Feed Rate, kg/hr	162	252	160	244	198	276
B. Average Water Added, kg/hr	0	0	0	0	2.97	9.66
C. Temperature Cooked, °C	146	170	149	170	135	171
D. Power, kW	11.2	28.6	11.2	28.7	14.7	36.2
E. Specific Energy, kWh/kg	0.069	0.113	0.067	0.118	0.074	0.131
3. CORN/GLANDLESS COTTONSEED						
A. Average Feed Rate, kg/hr	168	234	162	270	144	270
B. Average Water added, kg/hr	0	0	0	0	5.5	0
C. Temperature Cooked, °C	149	163	143	169	146	171
D. Power, kW	11.1	25.3	14.4	32.4	13.7	35.7
E. Specific Energy, kWh/kg	0.086	0.108	0.008	0.120	0.095	0.132
4. SOYBEAN/GLANDLESS COTTONSEED						
A. Average Feed Rate, kg/hr	174	243	168	294	180	255
B. Average Water Added, kg/hr	0	0	0	1.5	9.0	9.69
C. Temperature Cooked, °C	149	170	147	171	149	171
D. Power, kW	15.1	26.9	10.2	35.9	14.8	33.0
E. Specific Energy, kWh/kg	1.07	0.111	0.079	0.125	0.082	0.130

TABLE III - Vitamin Study

	Without Vitamins	Vitamins Added Inline	Vitamins Batch Blended
1. Whole Corn/Whole Soy			
A. Average Feed Rate, kg/hr	346.2	316.2	316.2
B. Average Water Added, kg/hr	10.2	10.2	10.2
C. Temperature Cooked, °C	163	163	163
D. Power, kW	21.2	33.4	34.1
E. Specific Energy, kWh/kg	0.090	0.106	0.108
2. Whole Corn/Dehulled Soy			
A. Average Feed Rate, kg/hr	328.2	316.2	316.2
B. Average Water Added, kg/hr	10.2	10.2	10.2
C. Temperature Cooked, °C	163	163	163
D. Power, kW	29.9	30.9	33.5
E. Specific Energy, kWh/kg	0.091	0.098	0.106
3. Dehulled Corn/Dehulled Soy			
A. Average Feed Rate, kg/hr	378.1	316.2	322.2
B. Average Water Added, kg/hr	12.1	10.2	10.2
C. Temperature Cooked, °C	163	163	163
D. Power, kW	38.8	31.4	38.1
E. Specific Energy, kWh/kg	0.103	0.993	0.118

TABLE IV - Test Parameters for Study on Effect of Processing Conditions on Product Viscosity

1. Percent Corn	47.5	47.5	47.5	47.5
2. Percent Sorghum	47.5	47.5	47.5	47.5
3. Percent Soybean	5.0	5.0	5.0	5.0
4. Average Feed Rate, kg/hr	450	444	444	462
5. Average Water Added, kg/hr	0	3.0	0	9.5
6. Temperature Cooked, °C	154	154	171	171
7. Power, kW	40.1	35.2	33.7	37.0
8. Specific Energy, kWh/kg	0.009	0.079	0.076	0.008

All products made were satisfactory; however, specific energies appeared higher for both cassava and potatoes compared with similar products using cereals.

TSP

An effort has been made to manufacture texturized soy protein (TSP) on LEC's. A 50 PDI (protein dispersion index) defatted soybean meal was used in the test design. Preconditioning of the meal was required as follows:

1. Pretempering of soymeal to approximately 30% moisture content.
2. Preheating of soymeal and water to 71°C.
3. Preblending with 0.1% sulfur addition.

Sulfur is an extrusion aid which is not suitable for human foods.

Comparative data are listed in Table VII The Brady could not produce TSP because of difficulties occurring with the feeding system. Transition plugs were frequent and texturization occurred inconsistently. The feed system was altered to incorporate the vibratory feeder. Results were more positive, but inconsistent texturization still occurred.

TSP was made successfully on the Insta-Pro extruder. Texturization occurred on a consistent basis and the product made was considered acceptable.

Consistent feeding to the extruder was necessary to produce TSP. When feeding was erratic, extrusion would generally be intermittent and would be followed by a long period of transition to reach equilibrium. It is felt at this time that the Insta-Pro is the only machine that can manufacture a consistent TSP product. More complete tests are scheduled for later this year based on the experience gained in this initial trial.

CURRENT MAINTENANCE AND DURABILITY DATA

CSU has been able to obtain specific data on certain machine-related problems for LEC operations over the past two years. Several items which have been noted are discussed below.

Drive Train Problems

The drive train for the Brady 206 crop cooker has caused considerable problems in Sri Lanka. Reports have indicated that universal joint center parts will last for only 300 hours before repair is required. Causes of drive train problems are:

1. The high torque transferred through the components.
2. The inability of the universal bearings to operate properly, thus causing severe wear of the race surfaces.

The universal joints generally heat up rapidly, which would be expected if the bearings were not adequately designed for the torque transferred. Reducing the power source and/or increasing the speed should reduce the load and the heat build-up. A smaller power source (lower hp) should be used which does not have the added power to continue running when operational or mechanical failure occurs, thus causing severe damage to components.

Sri Lanka has reported that the bolts which secure the cone in place on the Brady have sheared off. This problem is almost unique to this plant. The apparent explanation appears to be related to extruder plugs which occur in the plant. Reasons for the plugs are not apparent but may be related to the formulation with a low oil content. In the extraction of the rotor, the threaded holes in the end of the rotor have been strained by a puller attached there. Over a period of time, the bolts will not hold as designed. New bolts were installed in the rotor; however, these bolts were made of mild steel rather than high-tensile steel as specified. These bolts can shear easily if by chance the cone is adjusted too closely to the cup.

It has been somewhat difficult to identify the useful life of a specific extruder component. Data are available only for the plants in Sri Lanka and Tanzania.

Sri Lanka has indicated that a new Brady cone/cup replacement will last between 200-300 hours. Cones have been rebuilt using hard surface rod (HSR); however, the life is about one-half of the original cone.

Rotor wear (original) in Sri Lanka has been ranging between 200-400 hours of operation. Rebuilding the rotor with HSR has shown that the rotor will last up to four times as long as the original.

Tanzania has reported wear on cups and cones to be as low as 60 hours and rotor wear as few as 150 hours (moderately worn). Reasons for the excessive wear are not known; however, some of it may be attributed to the higher rotational speed of the rotor (1,000 rpm vs 540 rpm). The alternate cause may be due to some undetectable foreign material in the

TABLE V - Chickpea Blends

Test Parameters	CEREAL			
	50%	50%	50%	50%
Chickpea/Cereal	Corn	Sorghum	Rice	Wheat
A. Average Feed Rate, kg/hr	279.5	279.5	261.5	450
B. Average Water Added, kg/hr	9.5	9.5	9.5	0
C. Temperature Cooked, °C	160	166	153	154
D. Power, kW	21.4	35.1	19.7	35.4
E. Specific Energy, kWh/kg	.077	0.090	0.075	0.079
F. Uncooked Viscosity (cp)	71,200	50,860		

TABLE VI - Cassava and Potato Blends

Test Parameters	Percent Cereal Component				
	Cassava			Potatoes	
	50	60	70	40	70
1. Dehulled Soybean/Cassava					
A. Average Food Rate, kg/hr	648	516	437		
B. Average Water Added, kg/hr	0	0	5		
C. Temperature Cooked, °C	169	168	163		
D. Power, kW	66.7	65.1	58.4		
E. Specific Energy, kWh/kg	0.103	0.126	0.133		
2. Dehulled Soybean/Potato					
A. Average Food Rate, kg/hr				474	403
B. Average Water Added, kg/hr				0	1.1
C. Temperature Cooked, °C				167	170
D. Power, kW				54.2	48.8
E. Specific Energy kWh/kg				0.114	0.121

TABLE VII - TSP (Textured Soy Protein) Extrusion

1. Parts DSG (50 PDI)	100	100
2. Parts Water	30	30
3. Parts Sulfur	0.1	0.1
4. Steam to	82°C	82°C
5. Throughput, kg/hr	272	227
6. Screw Speed, RPM	650	300

aw materials, the presence of some soybean ulls and very hard, flinty corn.

CSU is working on the problems related to faster-than-expected wear. Clean raw materials and careful operations are certainly important. However, it is felt that the final solution may be improved metallurgical design of the extruder.

RELIABILITY OF LEC AND SYSTEM

Using a data-collection protocol, reliability information on LEC systems was gathered more extensively. The data below were compiled from the two operating plants, Sri Lanka and Tanzania.

Sri Lanka

Sri Lanka has been in operation since the Spring of 1976. This demonstration site was the first, and initial design deficiencies have been resolved. Reliability data are given for the most recent fiscal year, 1978.

Sri Lanka is using a Brady Model 206 powered by a diesel engine. The total system consists of storage, milling, cooling and bagging equipment. Cleaning of raw materials is done by a private miller who also manages the plan. Dehulling of raw materials has been omitted, since the final product of the plant is used as an extender for a PL 480 commodity, ICSM, and the percentage in the final blend is small.

Table VIII gives operating data for Sri Lanka. Operation efficiency, a comparison of actual hours worked to the scheduled hours, was 66%. Production efficiency, indicating the plant throughput when operating compared to the expected throughput, was 106%. Production on a per-scheduled-hour basis was 319.2 kg/hr.

Data in Table VIII give a breakdown on the operating efficiency of 66%. Examination indicates that the majority of the downtime was associated with material, transportation, power and labor problems. These items make up 64% of the downtime, leaving 36% to equipment-related problems. It can be concluded that given the management environment, the plant performed quite well.

Tanzania

Tanzania reliability data are given in Table IX. The data summarize five months of operation from June to November. The Tanzanian plant has a dehulling system for soybeans and receives corn grits from a nearby mill. The remainder of the processing system consists of milling, cooking, blending, and packaging equipment. Blending was incorporated into the plant so that vitamins and minerals could be added to the ground precooked formula. The plant has a Brady Model 2160 electric-powered extruder to heat-treat the raw corn and soybean mixture.

Operating data indicated that during the five-month period, the plant performed exceptionally well--93% of the scheduled operating time, producing 442 kg/scheduled hour.

As in the case of Sri Lanka, downtime for Tanzania was composed of largely non-equipment-related causes. Approximately 74% of the downtime was due to lack of material, power, late starts, or items which could not be identified.

Analysis of product formulation information during the five-month period indicated that the ingredient percentages used did not vary too significantly from the desired formula, except for the vitamins and minerals. Vitamin and mineral inputs were close to 30% lower than desired. This may be due to incorrectly weighing the blender ingredients. Operational changes have been instigated to correct this deficiency.

LEC—Brady Downtime Summary

One major objective of the demonstration sites is to evaluate the LEC systems while operating under production conditions. One method of evaluating the performance of the LEC system is to examine causes and frequency of downtime events.

Tables X and XI give data which describe downtime events and the percentage of the scheduled operating time that resulted. For the Sri Lanka plant, the majority of downtime was due to universal joint center parts on the drive train. These failures are a result of the high torque transmitted through the drive train. This problem has virtually been eliminated with the Tanzania system where the power train rotates at a higher speed, which means less torque being required for the same power. The remainder of downtime events are either wear-related or operator error.

MODIFICATIONS TO LEC SYSTEMS

The first LEC system with which CSU has been associated was installed in Sri Lanka in 1976; however, they are constructing a new facility which will be scheduled for the summer of 1979. Since that time, additional systems have been designed. They are located in

TABLE VIII. Sri Lanka Operating Summary

1. Scheduled working days - 253
2. Scheduled hours per day - 15
3. Scheduled production per hour - 455 kg/hr
4. Total hours worked - 2,514
5. Production recorded - 1,211,300 kg
6. Operating efficiency - 66.2%
7. Production efficiency - 106%
8. Production per scheduled hour - 319.2 kg/hr
9. Downtime (percent of scheduled time):
   A. Equipment-Related
      (1) Brady - 5.8%
      (2) Modern Mill - 0.2%
      (3) Conveyors - 1.7%
      (4) Diesel Engine - 2.0%
   B. Material-Related - 5.3%
   C. Labor-Related - 0.4%
   D. Power-Related - 3.3%
   E. Other - Lack of transportation - 8.3%
10. Product Formulation
   A. Desired
      (1) Maize - 75%
      (2) Soybean - 25%
   B. Actual (From Inventory Record)
      (1) Maize - 77.6%
      (2) Soybean - 22.4%

TABLE IX. Tanzania Operating Summary

1. Scheduled working days - 105
2. Scheduled hours per day - 8
3. Scheduled production per hour - 450 kg/hr
4. Total hours worked - 782
5. Production recorded - 371,320 kg
6. Operating efficiency - 93.1%
7. Production efficiency - 106%
8. Production per scheduled hour - 442.1 kg/hr
9. Downtime (percent of scheduled time):
   A. Equipment-Related
      (1) Brady - 2.1%
      (2) Modern Mill - 0.2%
   B. Material-Related - 1.8%
   C. Labor-Related - 0%
   D. Power-Related - 2.2%
   E. Other
      (1) Late start - 0.4%
      (2) Miscellaneous - 2.1%
10. Product Formulation
   A. Desired
      (1) Soybean - 27.7%
      (2) Maize - 54.8%
      (3) Milk - 5.0%
      (4) Vitamins - 0.1%
      (5) Minerals - 2.4%
   B. Actual (From Inventory Record)
      (1) Soybean - 25.75%
      (2) Maize - 68.5%
      (3) Milk - 4.1%
      (4) Vitamins - 0.05%
      (5) Minerals - 1.6%

TABLE X. Summary - Brady Downtime Sri Lanka

Event	Percent of Total Brady Downtime	Percent of Scheduled Hours
1. Old Cutters Broken	1.0	0.1
2. Broken Core Bolts	11.9	1.6
3. Worn Center Parts Kit	26.4	3.5
4. Broken PTO	5.9	0.8
5. Worn Core	5.4	0.7
6. Hydraulic Motor	10.9	1.5
7. Plug	13.6	1.8
8. Broken Cup Retainer Bolts	12.3	1.6
9. Overhaul of Brady	4.4	0.6
10. Transition Plug	0.3	0.1
11. Broken Cylinder Rib	8.0	1.1

TABLE XI. Summary - Brady Downtime Tanzania

Event	Percent of Total Brady Downtime	Percent of Scheduled Hours
1. Transition Plugs	83.3	1.8
2. Drive Train Shear Bolts Broken	4.6	0.1
3. Rotor-Related	12.1	0.23

Tanzania, Costa Rica and Guyana and are in various phases of planning or operation. Tanzania has been in operation for six months; Costa Rica is scheduled to begin production in February 1979; and Guyana in early summer 1979.

Changes and modifications have been made to each plant to expand its capabilities or improve its performance and durability. Modifications to the process systems are listed below.

1. Replacement of the screw conveyor carrying the extruded product to the cooler with a belt conveyor.
2. Incorporation of blending equipment to mix vitamin and minerals into the product.
3. Modification of the Brady crop cooker to eliminate the hydraulic feed system. The feeding system has been replaced with a vibratory feeding system directly to the extrusion screw.
4. Incorporation of an impact dehulling system to remove the hull from both soybeans and corn.
5. Incorporation of industrial screw conveyors, where applicable, to replace the light-duty screw conveyors.
6. Addition of cleaning and destoning equipment for raw materials.

Experience in Sri Lanka made it evident that the hydraulic fluid in the Brady was easily contaminated, causing considerable wear to the hydraulic components. Designs were developed at CSU to incorporate a vibratory feeding system to replace the existing injection auger. Tests made with this new system indicated that the extruder operation was not changed, but that the transition plug (a common operational problem) could be eliminated, since the transition is exposed to the atmosphere and can be unplugged with a soft probe should it occur. In addition, streaming back, caused by operational error, can be easily detected and corrective measures taken immediately. The new modifications are shown in Figure 1.

Modifications to the drive train and rear bearing of the Brady have also been examined by CSU to improve reliability. These modifications are only in a preliminary stage. Tests will be made and data gathered to ensure that these changes are necessary and do improve the ability of the Brady to operate on a continuous basis. These modifications are:

1. A continuous lubrication system for the rear bearing or incorporation of modification to the bearing housing to permit grease entry between the two bearings.
2. A continuous lubrication system for the universal joint center parts of the drive train.

Both of the above modifications are preliminarily designed to utilize an independent continuous lubrication system that would allow cooling of the lubricant. High-viscosity oil would be pumped through the bearing housing and through the universal housing assembly. When the modifications are refined and the data are collected, an announcement will be made.

SUMMARY

The evaluation of LEC's and systems has been extensive. They have been found to be effective processing tools for the production of low-cost nutritious foods using indigenous ingredients in LDC's. To date, most processing information exists in mixtures of cereal and soybeans.

Operating performance of LEC's has indicated they can be successfully operated in an LDC environment with operators and personnel having normal skills. Some modifications to the Brady extruder appear to have improved its performance and durability. Further data are being taken to document performances, systems and capital and operating costs.

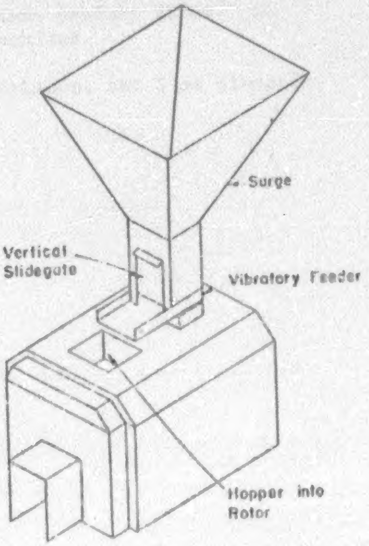

Figure 1. Brady feeder modification.

[illegible]

[illegible]

Results

[illegible]

Operating performance of [illegible]

Figure 1. [illegible] feeder modification.

[illegible]

5. Modification of the [illegible] feeding system. The feeding system has been [illegible] feeding system [illegible]

[illegible]

8. Addition of [illegible] cleaning and [illegible] equipment for the new [illegible]

Experience in 1971 [illegible] showed that the hydraulic limit of the drive was [illegible] feeding system to replace the existing [illegible] auger. [illegible] Figure 1.

Modifications to the drive train and [illegible] have also been [illegible] to improve reliability. [illegible]

Panel Presentation: Characteristics of LEC's and Manufacturing Experiences [1/]

Koehring Farm Equipment Division
3800 W. Wisconsin Avenue
P. O. Box 1279
Appleton, Wisconsin 54912

December 21, 1978

Mr. Ronald E. Tribelhorn
Department of Agricultural & Chemical Engineering
Colorado State University
Fort Collins, Colorado 80523

Dear Ron:

I am sorry to report that prior commitments do not permit the opportunity for us to participate in the L. E. C. Workshop in Tanzania. With this letter, I am asking you to relay my contributions to the panel discussion.

We at Koehring Farm Equipment Division are pleased with the continuing investigation and evaluation for the use of low-cost extrusion cookers. We feel that the machines can meet a real need in a number of areas in the world.

During the period since the first workshop in Colorado, we have continued to ship Brady extrusion cookers, many units going for the processing of foodstuffs. Most of these units have been shipped to less developed countries. From our continuing repair parts sales activity, we have confirmed that a large number of machines sold in previous years to farmers in the United States for livestock feed processing are continuing to be used for that purpose. The machine was introduced in 1971 initially for that purpose, and we have been pleased to participate in the application of similar units for food preparation in less developed countries.

Our company has made it known that we are interested in selling the Brady extrusion cooker product line to a qualified buyer who will further explore, service and exploit opportunities for the machine. We will be concentrating our efforts on our existing other agricultural equipment product lines. In the meantime, we will continue to sell and service machines.

I am sorry I cannot participate personally in this workshop, but I am pleased to be able to contribute in this brief manner.

Sincerely,

M. D. Van Peursem
President &
General Manager

MVP/mk

[1/] Mr. Van Peursem's letter was read to the assemblage by Mr. Tribelhorn.

Panel Discussion

Moderator:

Mr. Alden Ackels
Santa Rosa, California

Mr. Ackels:

To repeat a question from this morning, what are you going to do about parts that wear out too quickly?

Mr. Fox:

I'm answering strictly on bias, because nobody is referring to my machine. I think probably we've had five times the experience that anybody else has had with this. In other words, we've been making machines for ten years and we've run hundreds of thousands of tons. And let me tell you that nobody can tell you what kind of wear you're going to get on a machine until he knows (1) the product that you're going to run, (2) at what temperature you're going to cook it, and (3) how well you're going to clean the ingredients beforehand. There are many variable factors, and I'll give you two extremes. The first model 2000 extruder that ever came into Africa went into Uganda. A man by the name of Dr. Harrison started the program there in 1969, and he ran through the model 900 about 3,000 tons before he ever replaced a part. Now I must point out to you that every soybean was handwashed and dehulled before it went into the program--and I found that hard to believe myself. By the same token, I had a plant in Brownwood, Texas with 6 model 500's and we operated them 24 hours a day. We were processing soybean screenings--when you take soybeans from the U.S. they are supposed to be screened and the dirt, weed seeds, hulls and cracks removed--and we brought this product in and ran 1300 tons per month. The product ran from 12-to-27% ash; everything that won't burn is ash, as you know. That can be minerals, sand, dirt, whatever, and believe me, when you put 27% sand in an extruder, it isn't going to last very long. We kept a full-time welder in that plant, and every 8 hours we changed the barrels and the screws. When we changed shifts, one-by-one we pulled all the screws and rewelded them. You could rebuild a barrel about 4 times before it would actually break. In that plant we had replacement costs of $10.91 a ton for spare parts. Since we also had a $40-a-ton margin in the product, we could afford to spend $10.91. Then suddenly the price of oil went up, the price of the screenings went up, and we no longer had the margin so we shut the plant down. It's a matter of economics. My point is that one man runs 3,000 tons, and we have run as low as only three tons per machine before we had to replace parts.

One thing I noticed here yesterday is that all ingredients need to be well-cleaned because of the humidity and dirt in the air. I understood yesterday that you have had excessive wear on your machine here. I'm going to guess from the product that I ate yesterday that you're not getting quite so good a job of screening on that product as you should, although I didn't see the cleaning equipment. I know that the beans you have are very hard to process, and the reason you are not getting them dehulled is the fact that they are immature, green. I don't know what the moisture content was. When we first came out with this machine, we tested the bean by laying it on the floor and hitting it with a hammer. If it shattered, it would extrude well. If it flattened out you were in trouble, because then you had to screw that machine down until there was no clearance between the cone and the rotor. I noticed yesterday that the machine was running at 335°. At that temperature the product should have been a lot more puffed than it was, which indicates that the beans are a little doughy. It's very hard with the type of dehulling equipment you've got to dehull a bean of that structure. It's small, and when it hits those rollers, it has a tendency to just compress and then pop right back out with the hull intact.

Mr. Ackels:

Ron, I believe you and your associates did some work that indicated that the temperatures we are using might have some bearing on this problem. Do you want to mention that?

Mr. Tribelhorn:

In the evaluation we did--I'm sure most of you received a copy of the evaluation of the Brady--one of the things we found out was that with the high temperatures the parts maybe hardened, but that with time you get an annealing effect. In other words, it softens with time because of the temperature. This is particularly true of the cone; it's very hard, but after it's been used it gets softer as you go from the center to its outer edge which rides near the edge of the cup. The same thing is true of the rotor helix: it is very hard, but as you near the output end closer to the die, it tends to anneal also. I would like to mention that in Sri Lanka we originally had about 100-300 hours of processing time on a cone. We tried to rebuild those with hard surface rod, which helped, but they lasted only about half that time--150 hours. The rotor was in use 200-400 hours before it was worn out. We rebuilt it with hard surface rod with a Rockwell hardness of about 68. The data I've seen indicate that it lasted about 4 times longer, that is, about 800-1000 hours. In Tanzania we are getting a lot more wear, so we have instituted a rebuilding procedure here; however, the wear time is not quite so long as with the hard surface rod. I would like to get information from everybody else who has worked with the Brady in production situations or even in small demonstration sites as to what kind of experiences you have had concerning wear.

Ing. Clark:

We in Costa Rica produce 756 kilos of product an hour. In one year, or in 233 days, we produce 1.5 million kilos, and we only had wear every 800-to-1000 hours; so it really depends on the type of product and the raw materials. The rotor should give you at least 800 hours with no problem. Incidentally I wanted to mention, regarding flattened-down product, that the minimal puff we had yesterday is the result of defective raw materials.

Dr. Harper:

How much do you get on your cones?

Ing. Clark:

We have a system wherein we change the cones every three-to-four weeks to make sure we get longer use of the bearing and the rotor. If the bearing is new, the rotor will give you more output; conversely, if the rotor and the bearing are both getting worn, then you are going to get faster wear. So whenever you take out the rotor to clean it, or you have a plug-up, you check the bearing; if it is a little worn, put a new bearing on. In our experience this system gives a really good result, and because of the price of the rotor, you just can't operate without a system. And when the bearing starts to give you a hard time, you can be sure that you have a bad rotor.

Our present output of 756 kilos per hour is with a very dry product, using dry soy and the dry green peas. I don't know what's going to happen when we start working with local corn products, but with the dry green peas we have a really good output. We have no wear and our maintenance cost is perhaps ten times less than the maintenance cost you people have here. Our experience is that maintenance cost is insignificant. The only big cost for us is the hydraulic oil because it is very expensive, but maintenance cost due to wear is very small.

Mr. Nyakunga:

How is it that we have very good production efficiency if our soybeans are poor?

Mr. Sterner:

Let me first address this problem of wear. I have done some experimental work with rotating cones in the earlier model at Meals for Millions. Using a rotating cone on the screw similar to that of the Brady, I found that there was considerably more wear than there was in just a die plate. I also found when using 17-4 stainless steel that the heat did not anneal; in fact, the inner parts of the barrel that screw in actually became harder as the heat increased. Addressing your question more directly, in the product that I saw it appeared as if there were raw portions, large pieces of product that were really under-cooked. Even the outside, the finer grind which was more homogenous, had pieces only marginally cooked. I think your production rate is up because you are just not putting in that much energy. The more materials you put through, the shorter the residence time; therefore, your production is up and your wear is higher.

Mr. Fox:

My experience is that if the beans are soft, you have to raise the temperature to adequately process them. In order to raise the temperature, you apply more heat and pressure; anytime you apply more heat and pressure, you get more wear. My point earlier was that the product was being run at 335^{o}, which is fairly high and which means you are applying quite a bit of pressure to that bean. I also think there was abrasive matter in the corn, although I did not see it. I got that opinion because I tasted quite a bit of product. I agree that there were portions not adequately cooked and expanded. I didn't examine the product to try to determine whether they were chunks of soybean or corn, but I would almost bet that if you opened your modern mill you would find your hammers are very dull. Those hammers are reversible, that is, they have two cutting sides. Once the hammer becomes dull and you start getting larger particle size, you're going to have more difficulty cooking them and you're going to have more wear on your machine. It's cheaper to cut it with a hammer mill than it is to grind it with the extruder. As I said, I didn't see your cleaning equipment or the grains that were going into it, but I know you should have a more adequate job of cooking at 335° with that machine than you do. And if you're going to run it up to 335°, you're going to get more wear.

Ing. Clark:

What is the price of the new extruder, and is it possible to make a couple of small changes to the Brady to get the same results as we would get with the 303 but with a bigger output?

Mr. Sterner:

The 303 machine is basically $4,000, including its 30-h.p. motor. There are brochures here in case anyone would like one.

Dr. Harper:

What is the capacity?

Mr. Sterner:

The capacity is 68-136 kilograms.

Ing. Clark:

At 136 kilograms it is not comparable to the Brady.

Mr. Sterner:

Yes, I would say one of its disadvantages is that it has a limited production rate. We haven't really been able to do much test work on this machine, and the lack of evaluation is the biggest disadvantage.

Mr. Tribelhorn:

What kind of assistance are you prepared to give with fabrication of the machine and terms in developing countries?

Mr. Sterner:

Let me reemphasize that this machine is designed so that developing countries could in fact take care of their own machines, and, if they would like, copy it. We have no patent on this machine and don't intend to get one. The objective when we designed it was also that we could disseminate this machine to developing countries. What I mean by dissemination is not just getting a machine into a country and not supplying parts, but actually getting the country itself to fabricate it. This idea, of course, stems from Meals for Millions. We have found by past experience that it becomes quite costly to build only one unit in a country. We have occasionally been asked if we would send the plan to a particular country so they could just use it to copy the machine, but we've found some problems with that approach, too. I have a letter from a person who had built the screw without building the rest of the machine, and already he had gotten it wrong--it was a good thing that's all he had built. So we feel we would like to be more involved in the fabrication in-country, because we have somewhat of a reputation at stake and we have to safe-guard that reputation. I'm open for ideas as to how to go about this. I feel that if there are countries such as India--in fact, I must have at least 20 inquiries at the present time from India--it would seem possible to have a cooperative effort there to evaluate what kind of market there would be for this machine. If they wanted one in-country to evaluate, and if they felt it would suit their needs, then they could fabricate it for simple extrusion.

Ing. Clark:

One of the disadvantages of the Brady is that it can't shape product. With small modifications to the screw of the Brady, do you think it's possible to have it make shapes?

Mr. Tribelhorn:

Given the way it presently works, I do not think it is possible. We have tried various means, but the only way you're going to make shaped products with the Brady is to make some major modifications to it, which would mean designing a die plate-type system.

Dr. Harper:

I think it would also mean changing the screw.

Mr. Tribelhorn:

Yes, it would mean changing the screw and the bearings--you might as well start over. One of the things you would lose is the ability to adjust the machine while operating it. I think that Wayne Fox's machine, as far as shapes are concerned and for that capacity, is more applicable to the situation.

Mr. Lukoo:

One of the things that I've noticed on the Brady is that there is no specific device for recording the exact temperature of product at discharge. Another point is whether the fabricators can think of some way to coordinate the cone clearance with a measuring device on the control handle.

Mr. Fox:

Running any extruder--I don't care whether it is a Wenger, Anderson, or Brady or one of ours--is 60% art and 40% science. For example, we put out machines 10 years ago and never heard another thing from them except for parts orders. On the other hand, we put out machines two years ago and we've had telephone calls weekly for the last 2 years--at least 104 from that particular machine--and they still can't turn out product. And they are exactly the same machine. I am thoroughly convinced that any product you want can be run on an extruder, but you have to figure out the time-temperature-moisture relationships. You've got to go into these factors about cleanliness, the grind and that type of thing. That's all there is to extruding.

Most of the work that they've done on extruders at CSU has been with the Brady. They got the Brady about the same time as the Insta-Pro and hooked it up to the tractor--the Brady is easier to operate than the Insta-Pro extruder, but it doesn't have the capabilities that ours does. One of the reasons they did the original work on the Brady was that it had greater output capacity. But if you looked at Ron's data showing half again more capacity on the Brady, you have to remember that he was using an 85-h.p. input versus a 50-h.p. input; and if you would look at the kilograms per kilowatt, you will find that our machine took less power to achieve the same purpose. What I'm saying is that we were comparing apples to oranges there. We plan this year to make available to CSU a new model 2000 machine, which has had many changes made to it since they got their first machine. We changed the screw and die configurations and the volumetric feeders. We changed from a 2-inch screw to a 4-inch screw, which increases the capacity 4 or 5 times, and we got water injection systems. I invite any of you to come to Des Moines, Iowa to go through our plant and see what we're doing. We can make anything you want to make--now we may not do it the first time; it may take half a day to figure out how to do it, because the ingredients and humidity will affect an extruder. An extruder will run differently on a sunny day than it will on a rainy one. There is so much about extruders that you only learn by experience and by receiving information from people who have had the experience.

Mr. Bleyer:

I agree completely with Mr. Fox that this business is 60% art and 40% science. We have received a lot of good reports from Colorado about the work they have done and the scientific studies they have carried out. But it is true that on a very cloudy and wet day, my people just don't operate the machine because the product will be terrible, it will not be crunchy. And we have learned that in our 8 years of working with this machine, just as we have learned to make our own cones. For more than 2 years I haven't needed to buy any spare parts.

Commercial Marketing of Low-cost Extrusion Cooker (LEC) Foods

John P. Nichols
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The Texas Agricultural Market Research and Development Center
Texas A&M University

The problem of reaching ever-increasing
rs of people with an improved diet is
f the most important challenges facing
nd. The production and distribution of
tionally-improved foods is the primary
point for many organizations and insti-
ns throughout the world. In these
ts, many program alternatives have been
yed, including subsidized direct distri-
n programs, stimulation of local produc-
income supplementation and attempts at
raging commercial ventures in the area
tritional foods.

Marketing considerations are important
y effort where distribution of a product
volved or efforts are made to intervene
he market, even if the program is heavily
idized and not a commercial venture. But
basic principles and concepts of market-
are particularly crucial if the project
ased on commercial viability of the
uct. The nature and importance of these
eting concepts in commercial nutrition
rvention programs is the main theme of
paper.

Low-cost extrusion cooker (LEC) foods
ide the basic product concept, but the
r considerations are equally applicable
other nutrition-oriented products where
mmercial emphasis is involved.

In fact, most of the concepts discussed
e are common to the introduction and market
elopment for all commercial food products
ther they have some nutritional signifi-
ce or not.

There are, however, some unique con-
aintr which must be noted. These con-
aints stem from the specific goals and
ectives of the organizations often
ponsible for conceiving, developing and
rying out the nutrition intervention
ort. This difference is that the main
terion for success for these organizations
usually nutritional impact on a target
ulation. For a business firm in a commer-
l venture, it usually is some combination
sales, profit and return on investment.
e balancing of these two ways of evaluating
ccess in the project is a very difficult
ocess and requires the early attention of
l those involved. There should be no misunderstanding, however, that the role of the marketing program is significant regardless of how the project is to be evaluated.

The marketing of a product is a complex process guided by a number of factors, some of which are beyond the manager's (entrepreneur's) control. These factors will be outlined here in terms of the "non-controllable" influences (or the marketing environment) and the "control variables," or those which can be directly managed by the entrepreneur. In the process of outlining these factors, emphasis will be given to considerations unique to the commercial marketing of nutritionally-improved foods. Following this discussion of marketing factors, the importance of management, monitoring and control will be discussed with specific reference to research activitites which are appropriate for such projects.

THE MARKETING ENVIRONMENT

The economic, social and cultural environment in which the product will be marketed includes many forces which are either beyond the manager's control or can be changed only very slowly or with resources beyond those available. While these forces may be beyond control, they are nevertheless of great importance because they provide the basic framework within which the manager can operate and may pose significant constraints on the success of his efforts. Other factors exist which may be altered over time through successful marketing efforts but which are not subject to the direct control of the manager on a very precise basis. It is important, then, for all these "environmental" forces to be understood and evaluated in developing a plan for marketing of nutritionally-improved products. Four general factors are considered here: income, traditional consumption patterns, availability of raw materials and political constraints.

Income Level and Distribution

In most cases, the major factor influencing the potential success of a commercial venture is the availability of purchasing power among the target population. Two aspects are usually considered: one is the average level of income per capita, and the other is the distribution of income among consuming units.

In some cases, the average income may not be very low but an unequal distribution of income still leaves many with very restricted resources available for purchasing processed foods. Indeed, the very reason that the target population is receiving an inadequate diet may be related to inadequate incomes to buy the food already available. It must be recognized that a commercial marketing program will probably not reach all those who could benefit from the product. It needs to be viewed as an effort aimed toward those who will benefit nutritionally but who also have an income sufficient to purchase adequate quantities of the product. Other programs will be needed to reach those people who have no effective demand.

Often some information is available on income levels and distribution, though it may be dated and not clearly identify a relationship between income and nutritional status. Typically, it is concluded from general observation and a few studies that the primary beneficiaries are concentrated in the lower income groups. Whether these income groups will purchase and use the product in a nutritionally-significant way can only be finally determined through a market test.

Traditional Consumption Patterns

Another factor of critical importance in influencing the success of a commercial venture is the nature of typical food purchase and use among the target population. Modern marketing philosophy suggests that the best avenue to successful product introduction is through a process which begins by identifying a consumer need and then capitalizing on this need by producing and delivering a product which fills this need. This concept can be exploited in the case of marketing nutritionally-improved foods through a careful study of food consumption to identify product forms, packages and preparation methods that would be most readily accepted by consumers. Probability of success can be greatly enhanced by presenting a product to the consumer that doesn't require a major change in orientation toward feeding the family.

Several specific dimensions should be examined. The frequency and location of food purchasing provides useful background in selecting appropriate package sizes and types. The way the food is stored in the home before or between uses may influence design of packaging and shelf stability of the product. Food products and size of servings consumed by each member of the household will help identify ways of presenting the LEC food so that it has the best chance of reaching the intended population. Product formulation and recipe development may also be guided by information on typical preparation and serving procedures. These are examples of information that may be generated out of a survey research process. There is often a general awareness of some of these considerations, but the importance of reaching a commercial success requires that a careful documentation from a reasonably large sample be developed. It can be an invaluable guide in product development.

Availability of Raw Materials

Constraints are often imposed on the product and market development process by the lack of materials of various types. This is particularly true in developing economies where insufficient supplies of raw agricultural commodites, limited quantities of packaging materials and difficult storage conditions are too-often the norm. While many of the factors impinge first on the production process, they also have a direct bearing on the development of a logical marketing plan.

In distribution and marketing, consistency in quality and quantity of supply is a virtue of great significance. The development of a market is expensive and time-consuming. If the product cannot be delivered consistently, the major impact may be to disappoint the consumer and jeopardize the long-run success of the project. In developing economies where marketing conditions are often chaotic and supplies unpredictable, consumers may be less concerned about such problems. In such cases, however, it may provide an opportunity to achieve acceptance to a degree not otherwise possible if the product can be provided on a more dependable basis.

Coping with the problems of unpredictable supplies can be facilitated by planning ahead. Distribution can be expanded in a careful manner, alternative supply sources can be identified and variations in product formulation can be tested in advance to determine consumer reactions to changes made necessary by supply conditions. It is important to anticipate what problems could arise and develop contingency plans to alleviate any negative effects if they do occur.

Political and Institutional Constraints

Government policies often have a significant impact on the development of a commercially-viable, nutritionally-improved product. With LEC foods, as with all processed foods, the basic business environment, tax and incentive programs are important factors in developing a total marketing plan. Import regulations and restrictions on the use of foreign exchange must be recognized in assessing availability of ingredients, pro-g and packaging equipment and materials. g strategies may be influenced by l tax considerations, or more directly, orientation of government policy toward ing incentives encouraging development ommercial product.

mport restrictions may also provide a ted opportunity for developing a local t without having to compete directly imported foods. This may allow for less-expensive packaging or promotion ams and thus permit establishing the pro- t a lower retail price.

n additional example is the use of retail controls and other subsidized food ibution programs. Where retail price ols exist, pricing is essentially re- as a marketing factor under the control e firm. This may be true even if the ood is not directly controlled when substitutes are kept at a relatively r even subsidized price. The existence nstraints imposed by government policy be evaluated and considered in develop- marketing plan.

EGIC FACTORS IN MARKETING

Although there are many aspects of the ting environment which the manager can- ontrol, there is also a distinct and rtant set of factors over which he does considerable influence. Careful and berate use of these factors is the nce of good marketing management and is ial to the successful launching of a LEC product. It may be possible in some to be successful in spite of poor eting strategy, but in such cases the ntial nutritional impact will probably be reached. These strategic factors ude: product characteristics, pricing, aging, promotion and distribution nels.

uct Characteristics

While this might be considered in the ain of production, not marketing, it is rtant to note the importance of ascertain- the acceptability of the product among the get population. Characteristics such as vor, color and texture may be consciously ipulated (within technical constraints) produce a product which provides maximum sumer acceptance. A continuing research evaluation program can be carried out to mine and assess these qualitative aspects ing the product development phase. Such rogram should be a part of any comprehen- e marketing plan.

Pricing

Finding the right price for a LEC food product is both critical and difficult. The price is restricted on the lower side by the cost of producing and marketing the product and on the upper side by the effects of competing products, available income and perceived usefulness of the product among consumers. In the case of nutrition intervention programs, there is usually a desire to market the product at as low a price as possible consistent with covering all relevant costs. In this way, it is hoped that it will be within reach of those lower income groups thought to be most in need nutritionally.

It must be recognized that processed products usually will have to be priced higher to consumers than are basic staples or commodities. This is dictated by the costs of inputs through processing, transportation to and from a centralized facility and additional packaging often required. It is hoped that the convenience, nutrition and taste that may be added will be worth something to the consumer. But if the nutritionally-in-need consumer can't afford to buy the product, then there is no point in proceeding with the project.

Ultimately, only a market test can finally determine whether consumers in lower income groups refuse to buy the product because of its price relative to their income and the prices of alternative products. However, some investigation can be done in advance. If available, recent studies of income and price elasticities (relationships) for similar product groups can indicate how sensitive consumers might be to price changes and the effects of income on consumption. A survey of the marketplace to document competitors, their prices and sales level can give an indication of what the market will bear price-wise. Consumer surveys can be used to find out what people are buying among similar products and obtain an indication of attitudes toward hypothetical prices for the proposed LEC food.

Equally important is a detailed costing of the product as early in its development as is possible. This should include consideration of effects of changing ingredient prices, inflation and other contingencies. A realistic view of margins for selling costs, wholesaling and retailing and an appropriate return on investment must be included. Return to capital invested may vary depending on its source, but it should be explicitly recognized.

With an estimate of total costs which sets the minimum price, a judgment can be made as to whether it is too high, considering the product, its attributes and the competition. A definite conclusion may not be possible at this stage, thus requiring a test of the product under actual market conditions.

Packaging

The selection of packaging has an influence on shelf appearance and storage considerations. Once again, competititve factors are important, and a survey of competing products should provide insight regarding appropriate alternatives. With many foods, and especially with LEC foods, the packaging costs may well exceed the total of other processing costs, not including raw materials. Any savings which could be achieved in packaging would have an impact on final price.

However, it must be recognized that what the consumer sees first on the retail shelf is the package. It must combine attractiveness and strength sufficient to attract the consumer's eye and provide reassurance regarding the quality and sanitation of the product. In many developing economies the consumer appeal of products packaged in attractive tins is well-known. The price of these products is usually far above other local products, especially commodities sold in bulk but also including packaged items.

The problem for the manager then is to find the appropriate compromise which provides attractive quality packaging consistent with the desires of consumers and the pressure of increasing costs. Information on existing products, damage and losses in distribution and the availability of packaging materials can be gathered through interviews with distributors and suppliers. A survey of consumers may be helpful in determining the factors consumers consider important in packaging. Selection of graphic designs, colors and final artwork can often be done through the assistance of advertising agencies.

Promotion

To achieve nutritional impact the LEC product must be purchased and consumed by the target population. This is governed by the complex process of consumer behavior. The image of the product is more important than the product itself, whether we like it or not. To effectively and efficiently achieve the goal of improved nutrition a promotional component is required. This promotion effort typically includes public education and publicity programs, paid media advertising, point of sale advertising and the merchandising efforts of the sales staff.

The manager must effectively orchestrate a program which reaches to the target population and conveys the message which motivates consumers to purchase and use the product properly. Information on how food is being used in the home, what consumers are interested in with regard to food and knowledge of the strengths and weaknesses of the LEC product provide the basic foundations for developing the promotion effort. Consumer survey data are often useful in this process. In many cases, the nutritional strengths of the LEC product are emphasized in a general way (healthy, happy babies) to avoid having it characterized as a pharmaceutical. Convenience in storage and/or preparation and taste may also be emphasized. Each case is different and can only be developed in light of the specific consumption and marketing environment.

Distribution System

The manager also has the opportunity to decide how the product will be distributed. The selection of channels of distribution impacts directly on the availability of the product to consumers. In an effort to minimize distribution costs, a system may be selected which is not capable of getting the product on retail shelves in smaller stores and in rural areas. In some cases, retail outlets are limited to government stores which may not efficiently merchandize the product or reach the target population.

For a firm which already has a line of consumer food products, it will of course be logical to capitalize on its existing system of distribution. In some cases, however, the group which is promoting the LEC food is not currently distributing a food product. The fact that the nutrition impact objective often requires that the product be available in many small villages requires that a system be selected which can achieve this.

A good distribution system includes more than the capability of physically delivering the product. Motivation of wholesalers and retailers to keep the shelves stocked, promote the product at retail, and maintain product quality is also an important consideration. A strong and continuing sales effort is usually important in achieving maximum success. A distribution system with strong salesmen representation is also important in maintaining control over the product. The continuing follow-through of sales representatives can provide useful information on pricing, sales levels and appearance of the product at retail. It may be possible to achieve some distribution without it, but sales efforts, like promotion, packaging and attention to product characteristics, will usually be necessary to achieve widespread acceptance of the product among the target population.

Distribution systems should be developed on the base of existing systems in the economy. A review of these with firms that are involved at various levels in distribution channels will provide the manager a great deal of insight. Selection among systems and firms can then be based on a first-hand knowledge of the alternatives.

EVALUATION AND CONTROL IN THE MARKETING PROCESS

It has been indicated above that the manager has many decisions to make in developing a marketing plan for a LEC food. Both internally-and externally-generated information may be available to assist him in this decision-making process. Cost estimates and existing knowledge of prices, packaging and other variables may be readily organised for evaluation, but this is seldom sufficient for answering many of the most important questions. In some cases, the reliability of estimates of such considerations as consumer's reaction to price, levels of consumption, or the effects of alternative packaging is not known. To provide a more adequate information base for decision-making, an organized research and evaluation program should be considered early in the development process.

The particular objectives and research procedures employed will vary from one project to another and will depend on the nature of existing data and the goals expected to be achieved through introduction of the LEC food. Basic research procedures often employed and discussed briefly below include: consumption patterns surveys, consumer taste panel or acceptance studies, market tests and follow-up consumer surveys.

Consumption Patterns Surveys

Basic to all market development work for a LEC food is a knowledge of how it might be consumed in the household. As discussed earlier, the product should be developed with some idea in mind of the consumer need it will fill. Direct surveying of consumers is usually the best way to generate the necessary information. Secondary sources, such as recent government-conducted consumer expenditure surveys or nutrition studies, often provide useful guidance for a more detailed survey focused on the specific product groups of interest.

All aspects of purchase, storage, preparation, serving and consumption are typically included in such a study. Questionnaire development, sampling, fieldwork and analysis should follow commonly-accepted practices as outlined in various marketing research texts and handbooks. A study of this type can be designed to provide information not only on typical or "average" consumption patterns, but also how these may vary by population subgroup such as income level, ethnic group or size of household.

Many levels of sophistication can be adopted at this stage of research depending on how well-focused the product concept may be. In-depth studies may precede the large-scale consumer survey if general guidelines are needed to help focus the objectives sufficiently to permit efficient questionnaire design. The main consideration, regardless of the detail of questioning or size of the sample, is to generate information which will be useful in product development and selecting the "optimum" strategies to be included in the marketing plan.

Consumer Acceptance Studies

A wide array of research procedures falls into this category. The main purpose of such studies is to obtain an evaluation of the product or the product concept by consumers. This evaluation may be completed by having consumers try the product at a centralized location or by delivering and leaving the product for in-home trial. Consumers may be asked to rate the product regarding several qualitative factors or just indicate which of several variations they prefer. Samples of varying sizes may be used. The stage of product development, type of LEC food and similarity of the product to existing products all have a bearing on the actual procedures which are appropriate in a particular case. In addition to basic product characteristics (color, flavor, texture, odor, etc.), packaging, pricing and promotion concepts may be evaluated to some degree through the same survey.

Consumer-level evaluations are typically preceded by screening evaluations done using small lab panels. Because consumer panels are generally large enough in number to assure representativeness, they are also expensive and are not normally employed until the alternatives are fairly well defined and narrowed down to a very few. The lab panel evaluations provide the initial screening to narrow down the field so that the consumer evaluations can be done more efficiently.

Market Tests and Follow-up Surveys

Once a LEC product has successfully passed the consumer evaluation phase the final plans for test marketing are developed. This involves the development of a plan covering all of the strategic factors available to the manager as discussed above. The idea of a test market is to try the product out under actual competitive conditions of the marketplace, at the same time limiting the investment as much as possible. While execution of the market test is important, the test is useless if a system of monitoring the results is not adequately incorporated. This monitoring has three major facets: sales levels, consumer evaluations and reaction of wholesalers and retailers.

Determining the level of sales is an obvious task. This can be facilitated by using a test market area which covers essentially the same area as the normal sales or distribution territories, thus assuring more accurate reporting of sales. Sales data should be provided so they can be measured in some uniform units of time (day, week or month). It is also helpful if sales can be expressed on a "per-retail-outlet" basis and calculated separately for several sizes of retailer or different geographic areas.

Follow-up consumer surveys are necessary for the purpose of determining market penetration among various population subgroups, particularly the target population. These surveys can also provide another means of obtaining consumer evaluations and determining how the product is ultimately used in the household. Attention in designing this phase is also given to identifying reasons why consumers discontinue use of the LEC food or why it was never tried in the household.

A third aspect of monitoring the test market is the evaluation of the product's performance in the distribution channels. Salesmen's records and spot interviews with wholesalers and retailers may reveal problems in packaging, promotion or pricing and margins.

Taken together, this information from the market test provides the final evaluation of the product performance. This performance must then be evaluated against the goals for the product. Success may be obvious, thus leading to further plans for expanding the marketing to the entire region or country. If problems are identified, modifications can be made and test marketing continued or expanded. If serious problems are evident or obvious failure occurs, then test marketing is terminated. Without a logical plan for monitoring and controlling the test market, these decisions aren't always apparent. This is particularly true where the measure of success involves an evaluation of whether the product is reaching a specific target population and having nutritional impact.

FINDING SUPPORTING SERVICES

A large food company undertaking a project to develop and market LEC foods will often have marketing research resources readily available. For other firms and organizations, particularly in developing economies, this help may not be so readily available.

Marketing research firms are found in many countries and can perform survey research from questionnaire design through basic analysis. University professors skilled in market research may also be available. Under some conditions, large firms which have extensive marketing research capabilities may be willing to contract for outside work if it is compatible with their own priorities. Advertising agencies can usually provide assistance in developing promotional material and package designs. Government economic research and analysis departments may provide some studies on consumption and expenditure which will be helpful. Central banks may provide some similar data. Marketing research texts and handbooks provide a useful description of procedures which can be employed (see references).

While all of this may be available, it doesn't substitute for the development of a clear overview of the total marketing and research plan at an early stage in the project. This may require the use of outside consultants to provide a broad perspective consistent with the overall objectives of the firm, organization or agency involved. Such consultants may be found in-country or contacted through some international agency concerned with food and nutrition problems.

SUMMARY AND CONCLUSIONS

Success in marketing LEC foods to meet nutrition objectives depends on the recognition of constraints imposed by the marketing environment and the alternatives given the manager through marketing strategies under his control. Income, basic consumer preferences, availability of raw materials and the institutional setting are all beyond immediate control. Characteristics of the product, pricing, packaging, promotion and distribution channels are controllable, however. The way the "controllable" marketing variables are managed is crucial to the success of the project.

Effective management depends on the development of a sound marketing plan, which in turn depends on information and data gathered from both secondary sources and primary research efforts. Surveys of food consumption habits, studies of consumer evluation of specific LEC foods and market tests are all necessary components in the process of generating data for decision-making.

The role of marketing as a productive set of activities necessary for achieving maximum impact from a LEC food must be recognized by

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anagers of these projects. The development of a comprehensive marketing plan to guide these activities should be given a high priority by all who hope to have an impact on nutritional problems through the fostering of commercial LEC foods.

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Commercial THRIPOSHA Consumer Acceptance Test-Analysis of Principal Findings

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INTRODUCTION

Thriposha, a cereal-based fortified product, has been and is being distributed by CARE and the Ministry of Health, Government of Sri Lanka, to medically-identified recipients for the purpose of improving nutritional standards. Children and pregnant and nursing women who are identified as being nutritionally deficient are considered to be the primary target population. Distribution has been handled through the MCH Centers throughout the country. In 1978, the total distribution is expected to be approximately 14 million pounds at a rate of 1.5 kilograms per recipient per month.

It is felt that this system of distribution is operating at near-capacity. However, it is also felt that many nutritionally deficient people, particularly in the target population, are not being reached. Since food marketing and distribution systems exist which could be capitalized on to reach additional persons, a study was designed to examine the potential for commercially marketing Thriposha, in addition to continuing the free distribution program at existing levels. The study, as outlined in October 1977, included two phases: (1) an in-home consumer acceptance test, and (2) a test market.

The consumer acceptance or product concept test (Phase I) was designed to obtain an evaluation of Thriposha from a representative sample of consumers regarding various aspects of product quality, packaging, pricing and usage. The Market Research Department of Lever Brothers (Ceylon) Limited was commissioned to undertake this first phase. The intention of this first phase was to provide information of value which would help in the designing of the test market (Phase II). Phase I was not expected to provide all the answers regarding commercial marketing feasibility. A test market will be required to adequately assess potential sales levels and market penetration among target groups.

The field work for this first phase was conducted in January/March 1978. This paper is a report in capsule. Its aim is to point a picture of the principal findings so that the essence of the survey is captured.

THE SAMPLE

It was decided that the primary sample should be 750. This was divided into two primary strata: urban, 200 and rural, 550.

Both the rural and urban samples were selected from the wet zone sector of Sri Lanka.

The wet zone sector of the country is by far the most important sector. It lies in the southwest quarter of the island plus the central hill country (see Appendix I). Twelve of the twenty-two administrative districts are wholly or partially within this sector. It accounts for 69% of the country's population. The rural population of this sector accounts for 50% of the country's population and 65% of the total rural population (77.6% of the country's population is rural). The urban population of this sector accounts for 80% of the total urban population in the country. Seven of the eight biggest towns are in this sector. It is by far the most prosperous and fertile and has the most developed infrastructure, road network, trade distribution channels, etc.

The economic/social organization is more developed than in the rest of the country in terms of available amenities, hospitals, schools cinemas, etc. It is the most industrialized sector of Sri Lanka. Equally, within its boundary lie almost all the tea gardens, which earn Sri Lanka 50% of its export revenue, most of the rubber estates, which accounts for 15% of export earnings, and a large proportion of the coconut estates.

Avenues of employment are more diversified, and income levels are higher. Family ownership of consumer semi-durables like radios, bicycles and sewing machines is also higher.

The consumer in this sector is more sophisticated and open to modern ideas and way of life. It is the trend-setter, the leader.

The rural sample of 550 plus 105 additionalwas drawn from eight of twelve administrative districts in this sector. The eight districts are Colombo, Kalutara, Galle, Matara, Ratnapura, Kandy, Kegalle and Kurunegala, and they in total account for 84% of the zone's rural population. The urban sample was drawn from Galle, Kandy and Colombo and suburbs, the principal towns in these districts. The sample for each district, along with the population as well as the number of households, is given in Table I. In addition, the distribution of the rural sample is given graphically in Appendix I.

It must be noted that since the population in the Colombo District has fewer of the intended target groups, the sample for Colombo District was reduced and divided among the other districts.

METHODOLOGY

In the planning stage it was decided tha the test market, which was Phase II of the feasibility study, would be done in the administrative districts of Matara, Galle and Kand An additional rural sample was, therefore, drawn from these areas. The total rural sample, therefore, became 655--550 primary; 105 additional. The urban sample remained at 200.

After pre-testing the questionnaire in a pilot test, which also acted as a period of training for the investigators, actual field

Table I. Population in 000's

DISTRICTS	Total District Population			Wet Zone Population			Households in Rural Zone	Primary Sample	Add. Sample
	Urban	Rural	Total	Urban	Rural	Total		Rural	Rural
Colombo	1648	1352	3000	1648	1344	2992	240	80	
Kalutara	183	645	828	183	617	800	110	60	
Galle	177	652	829	177	642	819	110	60	50
Matara	74	584	658	74	577	651	100	60	25
Ratnapura	54	673	727	54	586	640	100	60	
Kegalle	52	677	729	52	615	667	110	60	
Kandy	165	1119	1284	165	910	1075	160	90	30
Kurunegala	49	1109	1158	40	715	755	130	80	
Total of 8) Districts)	2402	6811	9213	2393	6006	8399	1060	550	105
Balance 4) Districts)	178	1761	939	160	1140	1309	210		
Total Wet) Zone Sector)	2580	8572	10152	2553	7155	9708	1270		
Total) Sri Lanka)	3186	10984	14170	2553	7155	9708	1270		

work commenced on 18th January and was completed on the 9th March.

The investigators were divided into three teams of five each. Each team had four investigators and one supervisor and travelled in a car.

The random route sampling method was adopted in the urban areas and the random village method in the rural areas. Four interviews were done in each village contacted randomly. Each respondent was contacted twice. The first visit was to find out general food feeding habits of infants and children, usership and usage habits for Thriposha, attitudes and opinions on Thriposha, attitudes to the concept and price, and to give a sample for trial. The second visit, one week later, was to find out post-trial opinions.

The interviewee profile is given below.

The majority of the interviewees were wives, and the majority of them functioned as housewives. The majority were also below 40 years, young enough to be amenable to change. Between 30%-40% of interviewees were educated up to the O'level.

Seventy percent of the families interviewed have 3-6 persons, an average size of family in Sri Lanka; about 60% had children below the age of 6 years; and two-thirds of these families had infants. These groups are the primary target (Table III).

Ninety-two percent of the sample had heard of, seen, known about or used Thriposha. Seventy-five percent of this, or sixty-seven percent of the total sample, had used Thriposha at some time. Of these, seventy-five percent had not used it within the last month. In other words, seventy-five percent had used Thriposha more than one month ago (Table IV).

Table II. Interviewee Profile

PROFILE OF INTERVIEWEE CHARACTERISTICS
BY HOUSEHOLD INCOME LEVEL

Income Level (Rs/Mo)[1]	Interviewees who were "housewife"		Interviewees educated at the O' level minimum		Interviewees below age of 40	
	User	Non	User	Non	User	Non
	Percent					
101-200	92	88	24	23	92	93
201-300	95	83	49	35	96	93
301-400	93	95	58	43	95	92
401-600	87	92	59	75	88	92
All Groups	89	85	39	33	90	84

[1] U.S. $1 = Rs 15-

Table III. Size of Family and Age of Children in Sample Households by Income Level and Past Usage of Thriposha

Income Level (Rs/Mo)	3-6 Persons		Over 6 Persons		Under 1½ years		1½ - 3 years		4-6 years	
	User	Non	User	Non	User	Non	User	Non	User	Non
	Percent									
101-200	68	61	32	38	46	53	50	38	64	52
201-300	75	71	25	29	38	47	50	48	61	59
301-400	73	66	27	29	44	29	42	42	62	61
401-600	66	71	34	29	30	33	46	21	73	70
All Groups	70	68	30	31	42	42	47	38	68	58

Table IV. Last Usage of Triposha In Households By Income Group

Income Group Rs/Mo	Within last 2 weeks	Two-Four weeks	One-Three Mths.	Three-Six Mths.	Over Six Mths.	Total Users	Non Users	Total
	Percent							
101-200 (N=260)	12	8	13	11	26	70	30	100
201-300 (N=167)	7	9	14	10	25	65	35	100
301-400 (N=111)	12	7	17	9	20	65	35	100
401-600 (N=80)	5	14	10	7	34	70	30	100
All Groups	11	8	14	9	25	67	33	100

The distribution of sample by income and by users, non-users and both is given in Table V. Seventy percent of the sample were in the under-three-hundred rupees-per-month income group, and fifteen percent were in the Rs. 301-400 group. Seventy-one percent were in the primary target group, that is, in the income group Rs. 101-400.

The income distribution randomly arrived at for this survey is similar to that for the country as shown by other island surveys on income distribution.

SUMMARY OF PRINCIPAL FINDINGS

Among other things, the survey was designed to provide information in three key areas:

Table V. Distribution of Sample by Income; Users, Non-Users and Both

Income Level (Rs./Mo)	Users*	Non-Users	Both
	Percent		
100	13	15	14
101-200	36	31	35
201-300	36	24	22
301-400	15	15	15
401-600	10	9	11
600+	3	6	3
TOTAL	100	100	100

* Users are defined in all tables as those households who had used Thriposha at least once in the past regardless of how long ago.

1. Concept
2. Price
3. Product Characteristic/Performance/ Acceptability

The decision on whether to go on to the next step--that of a test market--depended on whether the findings in these key areas were positive.

The survey revealed that there were no major problems with the product, the product concept was well-received and understood, and the product characteristics and the performance of the product were found to be acceptable. In other words, the survey gave the green light to proceed to the test market phase.

1. The Product Concept

   This was found to have a strong level of acceptance among consumers. This level of acceptance was reinforced after use. Consumers were able to identify and accept the concept of Thriposha as being a "nutritious product" and "good for children." However, Thriposha was used by all members of the family.

2. Pricing

   This was a critical factor. The survey findings showed that pricing would be most important. Most consumers appeared to be sensitive to price levels, but the degree of sensitivity varied with income levels.

3. Product Characteristics/Performance/ Acceptability

   The basic and most important characteristics of the product were very acceptable to consumers. Its performance was considered good. There was a strong liking expressed for Thriposha in most product uses. Taste was the most important aspect in evaluating the product.

   The survey also revealed that the package size of one pound was highly desirable. The package should carry the connotation of "airtight and hygienic."

THE PRINCIPAL FINDINGS

1. The Product Concept

One of the keys to the entire questions of the commercial marketing of Thriposha was to find out whether the consumer would grasp the Thriposha concept--which is one of nutrition, vitamins, etc., for strength and energy--and believe and accept it.

The technique used to find this out was to:

(a) Administer the "willingness to try" scale after letting the respondent read a concept leaflet.

(b) Ask her to state what the strong and weak points of the product were after reading the concept leaflet and examining the product pack.

On the first visit each respondent was given a concept leaflet and asked to read it. She was then asked whether she would be willing to try the product if it were available in the shops. The degree of willingness or non-willingness was measured on a five-point "try" scale. On the second visit, too, after use of the product the "try" scale was administered. Therefore, each respondent was exposed to the "try" scale before and after use of the product.

The concept leaflet was in Sinhala or English and printed in color. It explained what the product was, its benefits, for whom it was meant, how it could be used, what preparation could be made from it and basic recipes.

Respondents' willingness to try Thriposha, before and after use, and intensity of response is shown in Table VI.

Table VI. Respondents' Willingness to Try Thriposha Before and After Use; by Income Group and Intensity of Response

Income Group (Rs/Mo)	Intensity or Response	Before		After	
		User	Non-User	User	Non-User
101-200	May Try	36	44	24	38
	Certainly Try	56	38	69	49
	TOTAL	92	82	93	87
201-300	May try	31	38	27	28
	Certainly Try	55	41	65	60
	TOTAL	86	79	92	88
301-400	May Try	23	37	27	34
	Certainly Try	71	53	68	45
	TOTAL	94	90	95	79
401-600	May Try	27	29	27	38
	Certainly Try	64	67	63	54
	TOTAL	91	96	90	92
All Groups	May Try	32	40	28	32
	Certainly Try	57	44	65	54
	TOTAL	89	84	93	86

The table shows that an overwhelming majority of respondents were willing to try the product on the basis of its promise. This indicates quite clearly that they understood and believed in the benefits that were promised. The table also shows that the willingness to try was reinforced after a week's trial. In other words, the respondents were of the opinion that the product performed well and up to the high standard they expected, and from this it could be deduced that they believed that Thriposha could and even would deliver the promised benefits.

On the first visit, after respondents had been administered the "try" scale, they were asked to read the concept leaflet once again, while at the same time looking at and examining the product pack (shown to respondents for first time), and to then state what the strong and weak points of the product were.

Table VII shows quite clearly that the number of respondents who mentioned strong points were the overwhelming majority.

Moreover, the table also clearly indicates that the product was discerned, understood and accepted, because "Nutritious" and "Good for children" came out strongest.

This is further strengthened by the importance shown to hygienic packaging (that the product is not packed in tins is seen as a weakness). Hygiene is a concomitant of food, and consumers associate top-quality food products with hygienic packaging.

Table VII. Strong and Weak Points Regarding Thriposha Given by Respondents After Reading Brochure (Before Actually Using)

Comments	Percent of Households		
	Users	Non-Users	Both
Strong Points			
Nutritious/full of vitamins	38	29	39
Good for children	24	21	26
Colorful/attractive	22	19	24
Hygienic packaging	18	11	17
Other comments	6	5	6
TOTAL*	92	64	91
Weak Points			
Would be better in tins	3	3	3
Other comments	10	3	8
TOTAL	11	5	10

*Total may not exceed 100 percent due to multiple responses.

2. Pricing

Pricing is another of the key areas. That pricing is a critical factor and that consumers are sensitive to price levels are too well-known to merit discussion. To obtain some indication of the right sort of price level--an indication intended to show a direction rather than an actual level--respondents were asked to give their opinion of a price or a "pay" scale. Three different prices (Rs. 2/-, Rs. 3/- and Rs. 4/- per pack) were tested, one-third of the sample for each of the three prices.

The technique used was to show each respondent a "four-point pay scale" card after she had expressed her opinion on the "try" scale. Each respondent was asked to indicate her willingness or non-willingness to buy Thriposha at the given price by selecting one of the statements on the "pay scale" card. The "pay scale" card was administered before and after use.

The findings revealed that pricing would be critical. The unit price would have to be at a level which would encourage consumers to buy and buy regularly. Otherwise, one of the key objectives, that of a regular intake of a prescribed quantity of Thriposha would not be achieved.

The test market would have to establish not only that a number of families are using Thriposha, but that they are using it regularly and at the right dosage level. Even though packaging costs are a constraint, the size of pack warrants further examination in order to ensure that the unit price is at the correct level. Of course, a possibility is to have two pack sizes.

Another consideration is that the price level must be in relation to directly competitive products like rice flour and wheat flour. Consumers might accept a premium for the plus point of nutrition offered by Thriposha, but it must not be too high to make it beyond the average housewives' purse. What must be avoided are the thoughts "I know it is nutritious and good for the children and worth buying, but I cannot afford it," or "I know it is nutritious and good for the children, but I cannot buy it regularly."

Table VIII shows the findings.

Table VIII. Percent of Respondents Indicating Willingness to Buy Thriposha at Given Price Level Expressed Before and After Using Sample, by Income Group and Past Usage of Product*

Income Group (Rs/Mo)	Rs.2/-		Rs.3/-		Rs.4/-	
	User	Non-User	User	Non-User	User	Non-User
	Percent					
101-200						
Before	53	54	25	43	21	36
After	50	57	25	38	24	37
201-300						
Before	70	71	37	67	31	42
After	66	74	26	47	22	24
301-400						
Before	67	92	48	59	40	60
After	72	64	40	54	30	50
401-600						
Before	65	100	29	75	35	50
After	74	100	33	75	19	43
All Groups						
Before	61	60	31	56	29	39
After	58	68	27	49	21	30

*Willingness to buy measured by total of those feeling price is "just right" and those feeling "could be priced higher."

3. Product Characteristics/Performance/Acceptability

The preparations made with Thriposha are shown in Table IX.

Table IX. Preparations Made by Respondents

Preparation	Percent of Households making each		
	Users	Non-Users	Both
	Percent		
Aggala	68	47	61
Rotti	52	59	55
Kirihodi	37	38	37
Drinks	30	32	31
Pittu	27	20	27
Porridge/Cungee	27	22	25
Stringhoppers	20	27	22
Hoppers	3	8	4
Thalapa	5	4	5
Curry	4	6	5
Aluwa/Kavin	3	3	3
Halapa	2	2	2

Aggala, a sweetmeat, was made by most respondents. Rotti, a flour preparation eaten mainly at breakfast but also sometimes at dinner as a change from rice, was also made by over 50% of respondents. A large number also made pittu/stringhoppers, preparations made from wheat flour or rice flour and eaten most often at breakfast and sometimes at dinner as a change from rice (in the urban areas the incidence of eating pittu/stringhoppers at dinner is increasing gradually). Kirihodi, a spiced gravy made of coconut milk and eaten regularly with rice and curry and stringhoppers and curry, was made by about 40% of respondents.

These preparations were made for and eaten by the entire family. Drinks and porridge/cungee were made mainly for children.

The survey revealed that the significant majority of respondents liked the product. Moreover, they liked Thriposha when used for each of the preparations. Least liked was Thriposha used as a drink, but even in this instance the score was over 70%.

The rating in detail for each of the main preparations is given in Table X.

The survey revealed that the main reason given for liking the product was "Taste" (Table XI). The opinion of children was also an important reason. Likewise, "Taste" and opinions of children were given as the main reasons for disliking the product.

Thus taste will be the critical factor in the formulation. Whether the price is considered too high or too low or just right, the vital consideration which will influence the decision to buy will be taste. This will have to be borne in mind when formulations are considered.

Respondents were asked to rate the product on a five-point scale "very good or very poor" for six main aspects of the product, namely, texture before preparation, texture after preparation, taste, color, appearance and aroma, for every preparation that they made.

The survey revealed that Thriposha performed well overall (Table XII). There were no major problems that surfaced, but taste, aroma and consistency needed to be carefully watched. Of course, as to be expected, Thriposha performed better in some of the preparations. It performed least well in Kirihodi and Drinks. Texture before preparation was rated highly for all the main preparations, but relatively less for Kirihodi, Rotti and Drinks compared to the others.

Texture after preparation was rated highly, but not so highly as texture before preparation. The category of drinks has been rated less highly than the others.

Taste, as has already been discussed, is the critical factor. It was rated fairly highly, but also there was a fair negative response that emerged and a fair number who neither liked nor disliked the taste. Aggala, the preparation made by most respondents, was rated best and Drinks poorest.

Color and Appearance were rated highly.

Aroma was rated highly, but there were also a considerable number of negatives.

Table X. Degree of Respondents' Like or Dislike for Thriposha Prepared in Different Ways: Users, Non-Users and Both

Way Prepared	Past Thriposha Users	Number of Households Using	RATING LEVEL			
			Liked a lot	Liked a little	Neither	Disliked a little
			Percent			
Porridge/Cungee	Users	135	69	16	9	4
	Non-Users	54	61	17	15	2
	Both	189	67	16	11	3
Kirihodi	Users	188	57	26	6	6
	Non-Users	93	55	20	8	14
	Both	281	57	24	6	9
Aggala	Users	343	81	12	4	2
	Non-Users	116	71	15	8	3
	Both	459	78	13	5	3
Pittu	Users	135	73	19	4	3
	Non-Users	68	62	25	7	4
	Both	203	69	21	5	3
Roti	Users	268	63	20	6	7
	Non-Users	147	55	20	10	7
	Both	415	60	20	8	7
Stringhoppers	Users	100	71	21	5	-
	Non-Users	66	64	27	5	3
	Both	166	68	24	5	1
Drinks	Users	151	59	19	9	7
	Non-Users	78	54	13	9	10
	Both	229	57	17	9	8

Table XI. Percent Of Respondents Giving Selected Reasons For Like Or Dislike of Thriposha By Way Prepared

Reason given for Like/Dislike	METHOD OF PREPARATION						
	Porridge/ Cungee	Kirihodi	Aggala	Pittu	Rotti	String-hoppers	Drinks
	Percent						
Taste	64	64	71	65	64	57	51
Children like/dislike	20	12	15	8	8	8	21
Consistency or texture	4	10	--	1	--	10	--
Nutritious	--	--	3	4	--	5	7
No. of Respondents	189	281	459	203	415	166	229

Table XII. Respondents' Evaluations of Thriposha as Used in Selected Preparations; by Past Experience with Thriposha (Users vs Non-Users)

Rating by use	CRITERION											
	Texture before		Texture after		Taste		Color		Appearance		Aroma	
	User	Non	User	Non	User	Non	User	Non	User	Non	User	Non
Aggala												
Very Good	26	18	29	29	46	35	26	23	25	22	25	22
Good	62	68	61	56	44	49	65	61	66	66	57	65
So-so	8	10	5	7	7	7	6	13	6	9	10	6
Poor	2	3	3	7	3	6	2	2	2	3	4	3
Very Poor	--	1	--	1	1	2	--	1	--	1	1	2
Can't say	2	--	1	--	--	1	1	--	--	--	3	3
Rotti												
Very Good	21	18	21	20	31	25	20	17	21	14	19	15
Good	61	63	59	62	46	50	66	62	64	67	58	59
So-so	11	11	10	10	13	10	10	18	10	14	15	16
Poor	5	5	6	5	9	12	2	1	3	3	5	7
Very Poor	--	1	2	1	1	4	--	1	1	1	1	2
Can't say	1	1	1	2	--	--	--	1	1	1	1	1
Porridge/Cungee												
Very Good	30	15	24	17	29	19	17	11	21	11	19	13
Good	56	65	67	61	50	56	73	81	67	78	56	63
So-so	7	9	5	13	13	11	7	6	10	9	13	13
Poor	3	4	2	6	4	6	1	--	--	2	6	2
Very Poor	--	--	1	2	2	7	--	2	1	--	1	7
Can't say	3	8	--	2	2	1	1	--	1	--	6	2
Kirihodi												
Very Good	16	15	20	18	22	24	14	12	13	11	12	13
Good	67	63	62	62	54	44	69	65	66	76	68	57
So-so	9	16	12	13	12	17	13	18	16	9	12	18
Poor	4	3	5	4	9	13	3	3	4	4	4	4
Very Poor	--	--	1	--	2	2	1	--	--	--	1	5
Can't say	4	2	--	2	1	--	1	2	--	--	3	2

Table XII. (Continued) Respondents' Evaluations of Thriposha as Used in Selected Preparations: By Past Experience With Thriposha (Users vs Non-Users)

Rating by Use	Texture before		Texture after		Taste		Color		Appearance		Aroma	
	User	Non	User	Non	User	Non	User	Non	User	Non	User	Non
Pittu												
Very Good	22	15	23	19	30	22	17	16	16	12	15	12
Good	64	74	62	61	55	63	73	74	74	76	65	62
So-so	7	4	10	13	6	4	6	9	6	9	13	12
Poor	3	1	3	1	7	9	3	—	3	1	6	7
Very Poor	—	1	1	1	1	1	—	1	—	1	1	6
Can't say	4	4	2	4	2	—	2	—	1	—	1	1
Stringhoppers												
Very Good	26	24	31	21	28	27	21	20	20	18	20	18
Good	58	61	52	59	62	58	65	68	67	73	64	61
So-so	5	11	8	9	7	12	8	11	9	6	10	12
Poor	7	3	6	9	2	3	4	1	4	3	3	5
Very Poor	1	--	1	--	1	--	--	--	--	--	--	2
Can't say	3	2	2	2	--	--	2	--	--	--	3	3
Drinks												
Very Good	16	14	18	12	19	10	12	13	13	13	11	10
Good	64	67	49	53	48	49	67	52	62	52	54	44
So-so	8	10	13	15	10	17	13	22	15	22	16	23
Poor	7	4	15	4	12	12	5	6	5	8	11	10
Very Poor	1	3	3	5	6	12	2	4	3	4	3	8
Can't say	4	3	3	1	5	1	1	3	3	1	5	5

Table XIII. Respondents' Comparison of Thriposha with Wheat and Rice Flour Used in Rotti, Pittu and Stringhoppers

	Texture before		Texture after		Color		Taste	
	User	Non	User	Non	User	Non	User	Non
Evaluation								
Comparison with wheat flour								
Both same	15	22	18	24	12	13	11	13
Wheat preferred	22	22	19	22	17	18	15	18
Thriposha preferred	62	51	62	49	70	65	73	64
Comparison with rice flour								
Both same	23	18	30	15	14	14	14	9
Rice preferred	23	33	19	36	22	27	22	37
Thriposha preferred	37	33	34	35	47	46	47	40
Doesn't know	17	15	17	14	17	15	17	--

Table XIV. Respondents' Opinions on Size of Package

Opinion	Users	Non-Users
Too little	24	16
Just right	74	83
Too much	--	--

Table XV. Respondents' Opinions Regarding Type of Package

	Percentage of Respondents*		
Opinion	Users	Non-Users	Both
Good/packeted well	70	69	69
Airtight/hygienic	22	77	20
Colorful/attractive	10	8	9
Would be better if packed in tins	9	11	10
Other Comments	9	6	8

*Total mayexceed 100 due to multiple responses.

CONCLUSION

In conclusion, the consumer acceptance or product/concept test revealed that the concept was understood, believed and accepted. It revealed that the product performed well and was accepted. Taste was a critical factor. It revealed that the consumer was sensitive to pricing. The price level was critical. It gave the green light to proceed to the next stage - that of the test market. This was what the consumer acceptance test was designed for. The test market now will have to provide answers to some important and critical questions upon which will depend the long-term success of this project.

It is not enough to have the concept understood, believed and accepted; what is needed is to find out to what extent this has been translated into regular buying action.

Consumers need to be fully aware of the inportance of nutrition and its problems - deficiency, minimum requirements and standards, regular intake of foods containing good nutritional values and/or fortified foods, value of a planned dietary programme. Special nutritional foods are now taken, it seems, as a special medicine. Motivation will be required for this. The test market will monitor the impact of motivation on consumer buying patterns.

Another key area would be the vehicle of intake. Sri Lanka is a rice-eating country. Rice is eaten at all meals. Almost everyone eats rice for lunch and dinner. Among the urban upper income groups there is occasional eating of western foods, or stringhoppers/hoppers/rotti/pittu, for dinner.

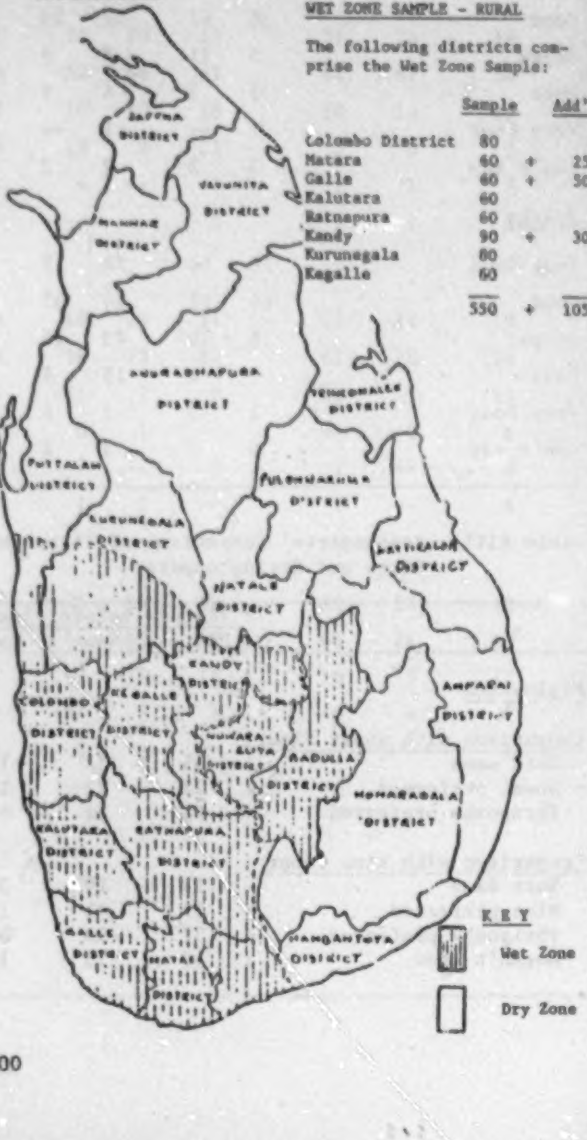
If Thriposha is to be taken regularly and in the prescribed quantity, then the vehicle of intake will have to fit and blend into the nutritional environment. Finally, the unit price, as well as its level in relation to competitive products is critical to achieve the objectives.

APPENDIX I

WET ZONE SAMPLE - RURAL

The following districts comprise the Wet Zone Sample:

	Sample		Add'l.
Colombo District	80		
Matara	60	+	25
Galle	60	+	50
Kalutara	60		
Ratnapura	60		
Kandy	90	+	30
Kurunegala	80		
Kegalle	60		
	550	+	105


JAFFNA DISTRICT
VAVUNIYA DISTRICT
MANNAR DISTRICT
ANURADHAPURA DISTRICT
TRINCOMALEE DISTRICT
PUTTALAM DISTRICT
POLONNARUWA DISTRICT
KURUNEGALA DISTRICT
BATTICALOA DISTRICT
MATALE DISTRICT
KANDY DISTRICT
AMPARAI DISTRICT
COLOMBO DISTRICT
KEGALLE DISTRICT
NUWARA-ELIYA DISTRICT
BADULLA DISTRICT
MONARAGALA DISTRICT
KALUTARA DISTRICT
RATNAPURA DISTRICT
GALLE DISTRICT
MATARA DISTRICT
HAMBANTOTA DISTRICT
KEY
Wet Zone
Dry Zone

Dr. Siegel:

I am wondering what your thoughts are on the topic of convenience-vs-nutritional characteristics of foods for low-income groups. It seems to me that people are not traditionally used to processed products, so when you promote a product like this on the market from a nutritional point of view, the message is likely to be lost on people particularly in village areas who don't understand that there is such a need for a special baby food in the first place. So we really need to educate people before we can market it successfully.

Mr. Corea:

I would say that if you are advertising or promoting this product your unique selling proposition--to use the technical jargon--would be on the nutritional aspect and not on the convenience aspect.

Dr. Siegel:

I don't agree completely because I understand that time is very limited for the housewife and villagers.

Dr. De Mel:

As one from Sri Lanka and as a mother, I think we need a convenience food. Thriposha has led the way in our country for the women who find it so difficult to put 1, 2, and 3 together to make a weaning food. It's all there and all processed, and I think that is one of the biggest things in its favor. It is considered both a convenience and a nutritious food.

Mr. Bleyer:

Dr. Nichols' paper was very interesting, but we face a different problem. You mentioned that you must go to the market to see what it needs and wants, and then you would have success because you are answering the needs with your product. This is not the case in Bolivia. In the instance of a weaning food, a hundred years ago people fed children with mother's milk and whatever traditional food was available. After that, in this century, the big multinational companies like Nestle have come in with an already-established image of weaning foods and how to use them. Now we go into business to both try to make profits for the company and to help people have the weaning food. All the things you mentioned are true, things that are needed to make a mark, but in this case you're not going to the people with what they want or what the market is waiting for, because the product is unknown. So you must create the market for your product, and I believe Coca Cola proved that it is possible. This problem and the problem of having to price the product so low-income people can buy it are our real difficulties.

Dr. Nichols:

I agree with almost everything you said. Perhaps you take me too literally when I say the market can tell you exactly what to make. It isn't that easy. It's an involved, subtle process that requires a lot of experience on the part of the person who's evaluating the information, and that's the type of experience you gain by being in business over the years. You've got a plant, a process and raw materials to start with, so what you are looking for is a general picture of whether you want to market a product in this area or that area--you don't just go out and decide that since the market wants panty hoses, even though you have been making food you are going to make pantyhose. What I'm saying is that you should be very conscious of the things you can do to the product that you want to create a need for so that it's easier to create that need, things like texture, flavor and the ability to be mixed in a certain way that fit in with what consumers normally use. Yes, you can create the demand for a particular product in the case of a weaning food, and we have to do a lot of education work. CARE is starting out in the case of Sri Lanka with the idea that the people need this, it's needed from a nutrition point of view, so we got a concept in mind of a weaning food to start with. But we still need to go to the marketplace to find out how best to develop the weaning food to make it fit into traditional consumption patterns. I don't think I'm at difference with you; perhaps in the process of presenting all these broad concepts, I spoke too literally or too generally. There's no doubt that it's going to take a lot of development effort, and that's where proper management, nutrition education, promotion, advertising, packaging, etc., are very important to sell the idea, to create the demand for weaning foods.

Dr. Bray:

From our experience with extensive market surveys in both Ecuador and Korea, nutrition is not going to sell products. It takes years of education for nutrition to come through to the people, and even then it's probably only to the upper-middle class. I think products only are going to sell on the basis that they taste good and are highly acceptable. All the organoleptic properties have got to be excellent. They have got to be better than the existing product. The route we've chosen might be of interest, and that is to not go with weaning foods first, but to go with weaning foods last and to first develop a market name for our company with the mothers by offering snack foods that they themselves would eat. Introducing the highly-nutritious foods later then seems like only a by-product of a good-tasting food.

Dr. Nichols:

In the case of Sri Lanka the name "Thriposha" is widely accepted--that's one reason why they are going with that for the product name--so that recognition of the name is not of major concern. The whole problem of selling nutrition is a real one, no doubt about it. I think it's a question of how you should go about selling nutrition. Certainly you build a case around flavor, convenience, and other attributes of the product, but it seems to me that if you focus on the image of healthy, happy, bouncing babies and not on the technicalities of nutrition, the idea of health and well-being and quality of life will get across through advertising and visual impressions--not try going out and telling people how good this is for you, you have to eat it. So you build a total program. We also have a major nutrition education program built into it that is not designed to sell more products; it's broader than that.

Mr. Corea:

Nutrition is, I agree, very difficult to get across. The consumer is going to be reached with a message which has nutrition in it, but the selling of it will present the end results like happy homes, bouncing babies, energy, and so on. But I would like to stress that in Sri Lanka there are a number of products which have been successful on the nutritional platform. One of them has not been in Sri Lanka for 10 years but has come back now in a big way. It is a product which is fairly high-priced, but it has a fantastic distribution system. Since it came back on the market 6 months ago, it has very quickly captured the same distribution that it had 10 years ago when it was readily available. It is sold wholly on a nourishing platform, but there is one problem--and this is a problem that you will probably have to face with Thriposha and overcome--and that is people think it is a medicine to be taken only when they are ill or rundown. Now that is not the objective of the Thriposha project, and this is a problem that has to be solved.

Dr. Camacho:

Dr. Nichols said a very important thing about marketing strategy. In Chihuahua we started first with a big campaign in order to promote the fact that full-fat soybean flour would be a good product nutritionally. We started to promote it in March 1979, but maybe for 6 months before we were talking with people such as teachers. The principal problem people had was understanding about the protein; that was the reason we tried to find some way to illustrate the equivalence, for example, to an egg and told them that they needed protein. Then you need some practical applications to show them what you mean. About the cost: we now have a cost of $0.51 for the full-fat soy flour. We are not quite in full production yet, but the product is explained in the supermarket, and with this additional campaign, it's been a good way to introduce nutrition to everyone. It is too early to judge the results, because we still don't have enough experience.

Mr. Nave:

So far I don't think we've talked about something that seems to me is quite important in India--I will call it the "snob appeal" image. In my opinion, you've got to make a product popular among a class of people which sets the pattern of behavior and desires of the rest of the population. I think this was shown by the tea industry in India, for instance. At first nobody would buy it except upper classes, and now it's into every little village in the most remote parts of the country. When we put our own product into the main store in Delhi, where we started it, we sent our people to the remote areas of the Bazaar to advertise it. People would say they were not interested, but when we told them they were buying it in Empire stores, they would say,"Then I'll take two packages." That's the way it got going. And I think that whole areas--and more importantly, large numbers of people--will buy things they don't need and don't want to begin with just because they are keeping up with people they admire or envy.

Dr. Nichols:

I would say that if that is the situation, it should be part of developing a sound promotion strategy for the product.

Sri Lanka Nutrition Intervention Projects Using Extruded Products

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Sri Lanka was one of the first countries in the Third World to appreciate the importance of correcting malnutrition caused by poverty and to introduce programs for achieving this objective. A scheme of subsidized food began as a wartime necessity, first in food marketing.

With the contraction in food supplies, it was imperative that measures to ensure equitable distribution of the available supply be implemented; hence, the rice-rationing scheme. In order to harness available domestic supplies for the rationing scheme, the government also made direct purchases of surplus stocks of paddy from the producers. These two forms of direct government involvement in rice procurement and distribution have continued to exist as cornerstones of government policy to improve consumer welfare and increase production.

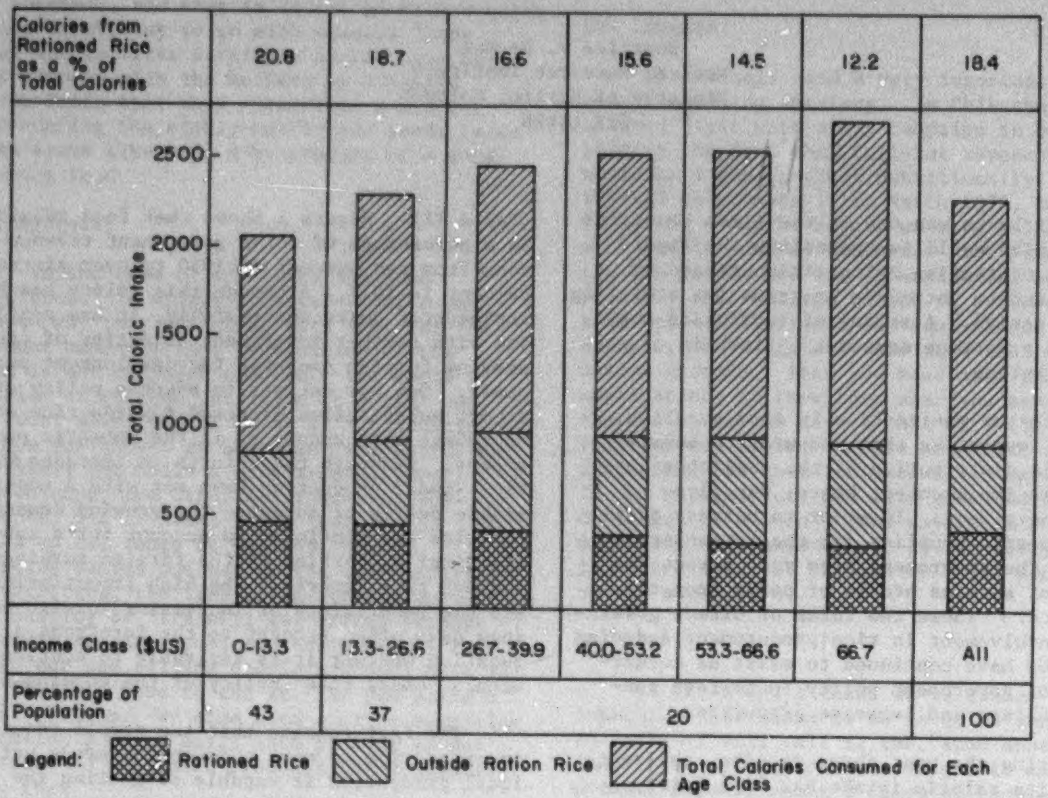
During the past three decades, apparent per capita calorie intake has been fairly adequate, and the comprehensive socio-economic survey of 1969/70 confirmed that direct government intervention has been the most important contributory factor in maintaining adequate nutritional standards.

The role of the rice-ration scheme in providing adequate nutrition to the people is shown in Table I. This table shows how the different economic classes benefit from the rice subsidy. Quantification of the nutritional benefit is easiest in the case of the free ration. The comprehensive information on consumption patterns given in the socio-economic survey makes it possible to discern the active and relative nutritional benefits by various income classes through the rationing scheme. As shown in Table I, the low-income classes have benefitted most from the free ration. For those with lowest incomes, free rice has accounted for 20% of the total calorie intake and 50% of the rice consumption. It is the numbers involved that give greater significance to the role of the rice ration. Those who gain most from the rice subsidy constitute over 80% of the population. The state, therefore, has committed itself to protect a vast majority of the population from the rising cost of living by distributing subsidized food to the consumer (Table II). Figure 1 shows that food subsidies as a percentage of total government revenue rose from ten percent in 1950 to over sixteen percent in 1977. Although this policy has been implemented quite successfully, it has conflicted with another government objective of conserving foreign exchange for development purposes. One way out was to adopt a policy of import substitution directed towards rice and to invest vast resources in the domestic paddy sector. Although the efforts to increase domestic paddy production have met with a considerable degree of success, the growing demand for rice has continued to account for a substantital proportion of the foreign earnings through rice imports. The high import prices and the uncertainty of increasing foreign earnings have often brought to the forefront a question whether it is desirable to continue with a "cheap rice" policy of the government.

The fact remains that the people require imported rice to meet consumption needs until local production is capable of meeting the domestic demand. Under these circumstances, the crucial problem is how best this rice should be distributed by the government. If the government's objective of protecting the low-income classes is to be achieved, it certainly means that the rice-rationing scheme with a price subsidy has to be continued, but the scheme has to be selective to ensure that the recipients are the most needy. Measures in this direction have already been taken. According to the recent changes in the rice-rationing scheme, the free ration of one pound and a further three pounds at Rs. 2.20 per measure works out at forty-four cents per pound and provides 900 calories and 18 grams of protein per day, which is approximately 40% and 30% of energy and protein requirements, respectively. This quantity was provided to 7,510,149 rice-ration holders in 1977/78, who were selected on the basis of the chief occupant's earning less than Rs3,600/per annum 1/ (Table III). An increase of income by the recent budget will reduce this number to around five million, which constitutes the bottom 35% of the population.

1/ U.S. $1 = Rs 15.

Table I. Sri Lanka: Apparent Per Capita Daily Caloric Intake From Rice, By Income Class 1969/70



Calories from Rationed Rice as a % of Total Calories	20.8	18.7	16.6	15.6	14.5	12.2	18.4
Income Class ($US)	0-13.3	13.3-26.6	26.7-39.9	40.0-53.2	53.3-66.6	66.7	All
Percentage of Population	43	37	20				100

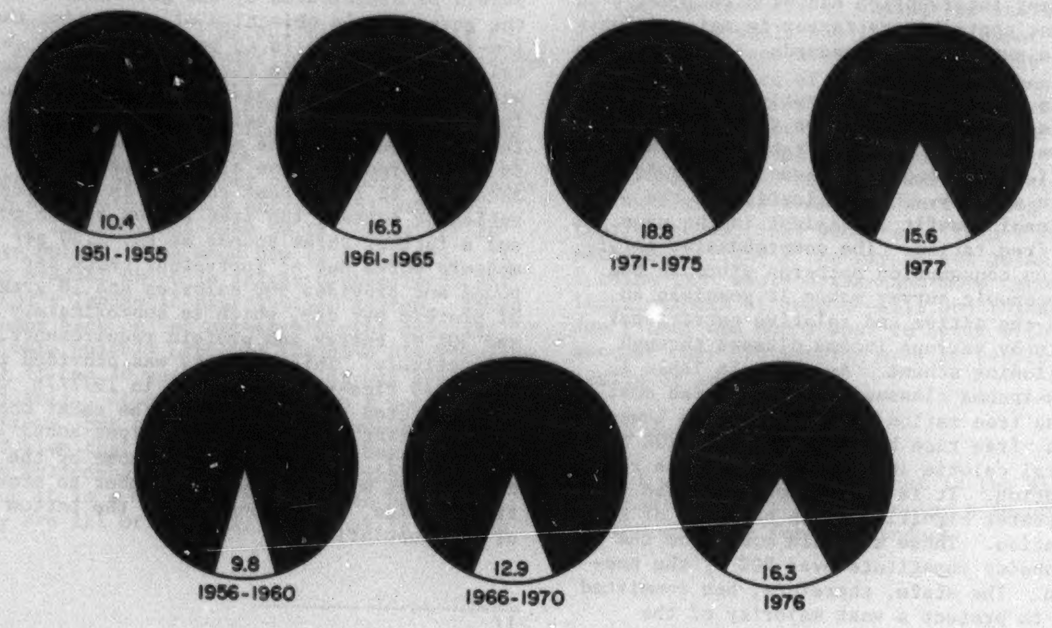


Figure 1. Food subsidies as a percentage of government revenue 1959-1977 (Rs millions).

Supporters of the subsidy claim that the system has the potential for major income distributional and nutritional benefits. In Pakistan, for example, the subsidy results in a real income increment of 9% to low-income recipients and provides 6-14% of recommended energy intakes for this group, depending on the standards used. Advocates also agree that in some countries subsidized food represents the cornerstone of overall basic need programs, which in addition to reducing the deprivation of the poor, may have contributed to a reduction in the rate of population growth. In Sri Lanka and the South Indian State of Kerala, the average per capita G.N.P. is $130 and $110, respectively. Both countries with similar subsidized food, health and education programs have birth rates that have fallen dramatically. In Sri Lanka the birth rate decreased from 38.7 to 27.5 between 1953 and 1976, and in Kerala from 39 to 26.5 between 1961 and 1974. Information on food distribution within the family is not available, but it is clear that calorie intake is closely related to per capita income. Since the poorest income groups have a substantially larger family size, the share of children that are malnourished becomes larger than the share of adults.

It is this distribution dimension of malnutrition--the association between malnutrition and poverty--that gives origin to a larger incidence of malnutrition among children.

One Indian survey shows that at very low levels of income, very young children experience a substantially larger calorie and protein deficiency than adults and older children. However, the young child's consumption increases rapidly with additional income.

In Sri Lanka there are four major nutritional problems: protein energy malnutrition; nutritional anemia; to a lesser extent, vitamin A deficiency (xerophthalmia) and goitre. The increasing evidence of these nutritional problems was confirmed by the National Nutrition Survey undertaken in 1975/76 by the Ministry of Health, with assistance from the United States Public Health Service, USAID and CARE. The survey documented the problems found in pre-school children (6-72 months of age) as summarized in Table IV.

Table II. Net Food Subsidy, 1975 to 1978 (Rupees Million)

ITEM	1975	1976	1977 Approved Estimates	1977 Revised Estimates	1978 Approved Estimates
I. Gross Food Subsidy	1,230.4	937.6	1,060.0	1,043.0	2,074.5
1. Losses on sale of foodstuffs	1,220.0	899.1	1,036.0	968.0	2,026.0
(a) Rice	786.5	680.3	707.0	831.7	1,251.5
(b) Flour	218.4	52.9	236.5	125.9	774.5
(c) Sugar	215.1	165.9	92.5	10.4	-
2. Subsidy on other foodstuffs	11.9	16.2	24.0	25.0	50.0
(a) Infant Milk	11.9	16.2	24.0	25.0	50.0
II. Net Food Subsidy	1,230.4	957.6	1,060.0	1,043.0	2,041.5

Source: Central Bank of Ceylon, Review of the Economy 1977.

Table III. Thriposha Coverage of Malnourished Vulnerable Groups in Sri Lanka October 1978

	1969/70 Diet-deficient Households +	1978 Rice-Ration Households*	Total Number of Thriposha Beneficiaries
Colombo	164,675	247,095	64,000
Jaffna & Mannar	55,725	101,508	39,105
Puttalam	23,589	55,963	11,541
Kalutara	36,056	94,371	18,136
Vavuniya	12,866	8,436	1,350
Kurunegala	63,075	153,150	41,876
Matara	74,531	132,868	17,502
Anuradhapura	35,130	58,274	39,329
Galle	64,321	98,959	23,960
Batticaloa	54,458	77,018**	25,684
Badulla	44,720	48,125	38,366
Kegalle	64,345	87,648	22,667
Matale	27,069	71,953	11,605
Ratnapura	53,713	96,506	9,379
Kandy	109,160	153,723	95,000
TOTAL	903,431	1,485,957	455,605
Total rice ration holders:		7,510,149	

+ Socio-economic survey - Census and Statistics
* Retain the rice ration as the household income is less than Rs. 300/per month ($19.50)
** Due to the cyclone, almost all households are getting free rice.

Protein Energy Malnutrition

Acute undernutrition, or wasting (deficit in weight-for-height), was prevalent in all the health divisions, but the central highlands were the worst affected. The survey also established that the problem of wasting was most acute in the second year of life, probably due to a poor weaning practice.

Chronic undernutrition, or stunting (deficit in height-for-age), affected 34.7% of the population, being worst again in these central highlands. However, the central highlands areas also include a large estate population, and the same survey showed that the estate areas were the worst affected, with a chronic undernutrition prevalence rate of 62.4%.

A combined ranking of the 15 SHS areas, determined by totalling the SHS rankings for the three commonly-used growth indices of weight-for-height, height-for-age and weight-for-age, indicated that the central highlands had the most undernutrition, Tables IV and V.

Nutritional Anemia

This is mainly due to iron deficiency and affects all ages, sexes and physiological groups, particularly pregnant women of the lower socio-economic group. The prevalence could be summarized as follows:

	Rural	Urban Poor
Pregnant women	52%	49%
Pre-school children	56%	49%
Adult men	35%	---

Table IV. Rates of Malnutrition in Pre-school Children by S. H. S. Areas

S.H.S. Areas	Infant Mortality Rate 1974/1976			Ranking of Malnutrition	Population under five years 1978	Gomez Classification				Waterlow Classification			Thriposha Beneficiaries - October 1978
	1974	1975	1976			Percentage of 2nd & 3rd Degree PEM - Children	Number of Children in 1st Degree PEM	Number of Children in 2nd Degree PEM	Number of Children in 3rd Degree PEM	Acute Undernutrition (Wasting) % of Preschool Children 8-71 Months	Chronic Undernutrition (Stunting) Chronically undernourished	Current Acute and Chronic Undernutrition % Acutely and Chronically	
Colombo	42	40	36	4	430,380	28.2	227,506	110,526	7,260	4.9	20.7	1.9	21,850
Jaffna	22	17	21	7	107,325	32.5	56,345	33,270	1,609	3.7	28.4	1.6	19,470
Puttalam	28	31	23	8	58,860	34.6	31,372	19,424	942	5.1	24.4	1.9	3,100
Kalutara	52	47	43	15	113,130	35.7	59,732	35,183	5,204	6.2	26.8	3.4	8,830
Vavuniya	23	24	38	16	26,055	36.4	13,757	8,910	573	5.8	29.6	2.3	Inc. Jfn
Kurunegala	38	37	41	19	157,545	39.6	81,450	58,764	3,623	5.7	30.4	2.3	10,965
Matara	42	41	41	19	143,640	37.2	77,134	48,837	4,596	6.0	29.7	2.2	8,685
Anuradhapura	36	35	36	24	88,290	38.4	47,500	32,138	1,765	6.9	30.7	2.9	7,906
Galle	50	50	45	31	113,670	40.6	53,993	45,240	5,457	8.2	33.3	4.1	6,328
Batticaloa	45	50	49	32	81,270	42.3	37,628	31,289	3,088	8.4	36.5	4.0	9,233
Badulla	73	56	51	33	118,935	50.6	51,736	53,282	6,898	5.8	49.4	4.0	16,602
Kegalle	60	54	51	34	101,790	45.4	48,146	41,225	4,987	7.1	39.6	4.0	7,688
Matale	65	49	53	35	71,685	46.0	33,047	30,323	2,652	7.2	38.9	3.8	6,887
Ratnapura	66	63	64	39	101,250	49.7	43,958	46,699	3,756	8.8	37.3	4.1	6,527
Kandy	92	72	61	44	243,675	54.7	96,982	115,939	17,300	8.5	49.6	5.5	49,652
TOTAL					1,930,770	42.1*	960,286	711,100	69,710	6.6*	34.7*	3.4*	183,722

*Percentage total rural Sri Lanka.

SHS AREAS	Maternal Mortality Rate for 1974/1976			No. of Pregnant Mothers	No. of Severely Anemic Mothers	Crude Birth Rate		Singulate Mean Age at Marriage	Thriposha Bens. October '78	Percentage Covered by Th. Program
	1974	1975	1976			1972	1977			
Colombo	0.5	0.3	0.3	89,640	17,928	28.2	25.1	24.4	14,484	80.78
Galle	0.6	0.9	1.3	25,260	6,215	25.0	24.7	25.8	2,459	38.93
Jaffna	0.7	0.4	0.3	23,850	5,962	29.5	26.6	23.4	7,183	96.94
Vavuniya	0.8	1.2	1.3	5,790	1,447	37.9	34.6	20.3	Jaffna	-
Kegalle	0.8	1.5	1.0	22,620	5,655	23.1	22.1	24.4	1,895	33.52
Ratnapura	0.8	1.8	1.1	22,560	5,640	30.6	31.9	23.8	2,722	48.26
Kalutara	0.9	1.0	0.6	25,140	6,265	28.8	27.1	25.2	2,896	46.07
Anuradhapura	1.1	1.2	1.0	19,620	4,905	33.5	37.7	21.4	2,336	47.62
Kurunegala	1.2	0.9	1.0	35,010	8,752	28.8	25.6	22.8	5,055	57.75
Badulla	1.4	1.4	1.1	26,430	7,929	34.8	26.4	23.8	6,830	86.13
Puttalam	1.5	1.2	1.2	13,080	3,270	33.2	31.1	22.1	2,282	69.78
Batticaloa	1.5	2.1	1.0	18,060	4,513	38.3	35.0	20.1	1,832	40.57
Matara	1.6	0.7	0.5	31,920	7,980	31.5	26.1	25.7	2,508	31.42
Matale	1.6	0.7	1.1	15,930	3,982	31.0	27.4	22.7	2,104	52.83
Kandy	2.6	1.6	1.4	54,150	21,660	31.6	25.0	24.4	16,749	77.32
Weighted Average Sri Lanka	1.0	1.0	0.9*					23.5		
TOTAL				429,060	112,225	30.1	27.5		71,336	

*Lowest in recorded history.

In the case of pregnant women, studies have established that iron, folate and, to a lesser extent, vitamin B_{12} deficiencies contribute to the problem:

Iron deficiency	46.0%
Folate deficiency	20.0%
B_{12} deficiency	6.9%

Vitamin A Deficiency

This was identified as an important public health problem in only two of the 16 health divisions of the country (Kegalle & Matara) by the National Nutrition Survey conducted in 1975/76. Prevalence rates for night blindness and Bitots' spots in these two areas marginally exceeded the 2% prevalence levels laid down by the W.H.O. as criteria for the recognition of a vitamin A problem of public health importance, with maximum figures of 2.6 and 2.3% for night blindness and Bitots' spots, respectively. Serum vitamin A estimations on a subsample of the children confirmed that vitamin A deficiency was only a marginal problem in Sri Lanka.

Endemic Goitre

Endemic goitre is a problem in the S.W. coastal belt and the central regions of the country which have a high rainfall. The resultant heavy leaching of the soil of its iodine content could be the causative factor, as the condition has been identified as being mainly due to a decifiency of dietary iodine. However, since the S.W. coastal belt is the most densely populated area of the country (over 70% of the population reside within this area), this percentage of the population is "at risk" of endemic goitre.

Approaches

As a major nutritional deficiency is protein energy malnutrition, the main strategy must be through coordinated development efforts with generation of increased income, agricultural production and health and education strategies. It is important to close the calorie gap if the protein intake is to be correctly utilized. There must hence be a massive government intervention to maximize the output of energy per resource cost (i.e., the scarce resources--land, water and capital). With the present accent on rice production, it is well to increase higher calorie-yielding crops like tubers (yam, sweet potato) that are less water and capital intensive to obtain self-sufficiency in energy (calories), rather than to focus on rice alone. This is the best approach to the problems of maximizing land use and diversifying crop production, thereby improving the income of the small farmer. Meeting protein needs with a supply of animal protein raises many difficulties and may take longer to achieve. It is necessary to place greater emphasis on locally-grown pulses such as cowpea, green gram, pigeon pea and soya. Soya stands out as the best source of protein for inexpensive formulated foods, as it provides the most protein for the money. It is also a good source of oil, which is now in short supply due to the dwindling supply of coconuts.

Nutritional Contribution of Thriposha

Thriposha provides a daily food supplement of 50 grams. The nutritional composition of the various components used in blending Thriposha are shown in Table VI. Of particular nutritional interest are the significant concentrations of protein, calcium, iron, vitamin A, folic acid, vitamin B_{12} and ascorbic acid present in ICSM. There is also a high concentration of lysine, which is usually the limiting amino acid in cereal-eating countries. Local grains (corn/soya) are blended (25%) in the formulation of Thriposha. This dilutes the nutritional contribution to some extent, as the indigenous product is at present without mineral/vitamin fortification (Table VII). It is important that the totally indigenous Thriposha--the formulation of corn/soya--of the future be fortified with methionine. The only essential amino acid in ICSM that is below the FAO/WHO suggested level is methionine-cystine, even with 5.0% non-fat dry milk added to the formulation.

Nutritional Contribution for Pregnant and Lactating Women

Thriposha contributes approximately 1/4 or more of the daily recommended allowance for minerals, calcium and iron, vitamins, thiamine, folic acid, vitamin B_{12}, niacin and ascorbic acid for lactating mothers (Table VIII). The vitamin A contribution is of particular significance in Sri Lanka, as it increases the concentration of this vitamin in the mother's milk. This is probably one reason that the symptoms of vitamin A deficiency have declined in the very young child of the poor. For pregnant women, Thriposha contributes at least 25% of all the recommended nutrient allowances with the exception of energy, which can, however, be obtained from many cheap food sources that are not so rich in other essential nutrients. However, if Thriposha is taken for at least 150 days of the pregnancy by low-income group mothers, then the 20,000 extra calories obtained will help obtain a considerably higher weight gain and a birth weight of over 2,500 grams.

Research has demonstrated the very close relationship between infection and malnutrition (Scrimshaw et al., 1965). Including a health component with a nutrition intervention, therefore, will significantly improve the chances of the infant and pre-schooler to survive and to effectively use the nutritional input (Figure 2). Conversely, the nutrition component will have a similar positive effect on the health input.

There are several different ways this can be done. In some cases, for instance, supplementary rations are used as an incentive to encourage people (especially mothers) to attend government health centers. As the mother picks up the ration (weekly, biweekly or monthly), she and her child are given health check-ups. An example of such a program was found in Project Poshak (Gopaldas et al., 1975).

The Family Health Program of the MOH is fundamentally geared to the integrated approach where the reduction of malnutrition, infection and consequences of childbearing are the center of all activitites. Nutritional activities are being promoted as part of Family Health, the most important of which are feeding programs to the mothers as a prevention against low birth-weight babies; collaborative studies on breast-feeding; simple anthropometric methods of monitoring the nutritional state and growth of the child in its critical first years of life; feeding programs especially directed to the children at risk and for rehabilitating the severely malnourished child; and the control of xerophthalmia and nutritional anemia.

Relevant health and nutrition education intervention, with messages that are directly aimed at breaking the links that lead to malnutrition, infection and uncontrolled childbearing, are now being promoted.

Progress/Review

The Sri Lankan Government has traditionally placed high priority on health, education and nutrition intervention programs. The Ministry of Education increased its expenditure from $1.5 million in 1973 to $2.5 million in 1976, although total capital expenditures were only $5.1 million. The MOE contribution accounts for 55% of its budget for capital expenditures. In addition, the Ministry of Health spends about 30% of its capital expenditures and 3% of its total budget for the MCH project, plus distribution of Thriposha to schools and institutions.

Table VI. Nutritive Value of Nutrients Found in Thriposha (Values per 100 g Finished Dry Commodity)

Nutrients	ICSM	Corn	Soy-fortified flour 1/
Food Energy Calories	380	348	357
Protein, grams	20.0	8.9	16.0
Crude fat, grams	6.0	3.9	1.3
Crude fiber, grams	1.2	2.0	0.6
Fat, grams	4.0	1.2	1.8
Carbohydrates, grams	60	72.0	72.0
Calcium mgs.	900	22	211
Phosphorus mgs.	700	268	182
Iron mgs.	18	2.1	5.0
Vitamin A IU	1,700	490	882
Thiamine (B_1) mgs.	0.8	.37	.64
Riboflavin (B_2) mgs.	0.6	.12	.36
Niacin mgs.	8	2.2	4.6
Ascorbic acid mgs.	40	-	-
Lysine million grams/ gram protein 55*	58	29	28
Methionine - Cystine 35*	28	-	-
Protein Efficiency Rate (PER)	2.4	1.2	1.9

1/ Soy-fortified flour at 12 percent
* FAO/WHO suggested level
SOURCE: FFP PL480 Title II Commodities Reference Guide, 3/1/78.

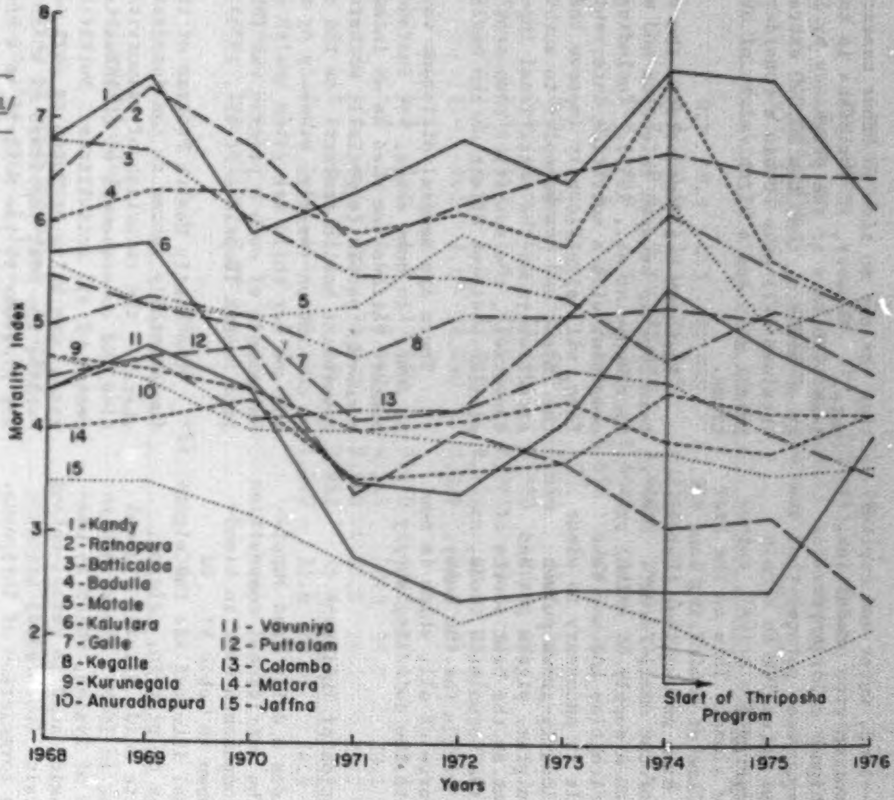


Figure 2. Mortality index before and after inception of Thriposha program.

Table VII. Nutritive Value Selected Nutrients, Contribution of 50 Grams Daily

	Thriposha	Thriposha totally indigenous without mineral and vitamin fortification
Food Energy Kcal	190	185
Protein, grams	10.0	9.9
Crude Fat, grams	3	3.1
Crude Fiber, grams	0.6	0.9
Ash, grams	2.0	1.8
Carbohydrate, grams	30.0	31.5
Calcium, mgs.	450	340
Iron, mgs.	9	6.9
Folic Acid, mgs.	100	--
Vitamin B_{12}, mgs.	2	--
Vitamin A IU	850	698

Table VIII. Nutritional Contribution of 50 Grams of Thriposha: Percent of Daily Recommended Nutrient Allownace for Sri Lankan Mothers and Young Children

	Nutrient Allowance in Percentage										
Type of Participant	Food Energy Kcal	Protein	Calcium	Iron	Vit. A	Thiamine	Riboflavin	Fol. Acid	Niacin	Vit. B12	Ascorbic Acid
Male/Female[a]											
1-3 years	16	42	100	110	340	80	38	79	44	177	100
4-6 years	11	32	100	110	283	57	27	79	33	106	100
Female											
20-29 years pregnant	10	24	100	32	113	44	23	25	30	53	66
20-29 years lactating	8	14	45	23	71	36	18	33	22	64	66

[a] Individual average weight per Kg. ages 1-3, 12.0; ages 4-6, 18.2; ages 20-29 (female) 47.0; ages 20-29 (female lactating), 47.0.

SOURCE: Department of Nutrition, Medical Research Institute, Colombo, 1976.

Sri Lanka's extensive health, education and transportation (roads and vehicles) systems facilitate the distribution of food to target groups. The current program is to extend these services to other critical areas such as the estates.

A lack of a community development orientation serves as a major constraint of the program. The central government of Sri Lanka has already committed sizeable sums of money, so any further government input will have to come from the local community level. Traditional government support to welfare programs may have contributed to less self-reliance on the community's part. Despite poverty, there is scope for community involvement as a means of balancing the program from the bottom up. The School Feeding Project could benefit from community-provided foods, and MCH could use the help of community health workers. Therefore, these two areas might become targets for community organization efforts. Greater efforts on the part of program participants may be required to organize such activities. Coordination with Sarvodaya, a Sri Lanka community organization, is now being implemented on a small scale in the Thriposha Program and has shown that community participation is possible and effective in strengthening the impact of the program.

The LEC Program in Sri Lanka

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Thriposha Program
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HISTORICAL BACKGROUND OF THE THRIPOSHA PROGRAM

The origin of the Thriposha Program dates back to March 1972, when CARE submitted a pre-plan project proposal for consideration to the Ministry of Planning to develop a nutritional weaning food made exclusively from indigenous foodstuffs fortified with a vitamin/mineral additive. This product was to be used to support the government's social service programs and to fill the commerical market demands of the low-and medium-income groups. The timing of the presentation of this proposal coincided with a period in Sri Lanka of short supply of milk food products, which eventually led to the termination of the daily primary school milk program supported by CARE.

To support the feasibility of the pre-plan proposal CARE developed a weaning food composed of a wheat/soya blend, non-fat dried milk and rice flour and tested the consumer acceptability of the product. The consumer results of this study were very encouraging. In April, CARE received approval from the Ministry of Planning to proceed with the formulation of the project in consultation with the Ministry of Health. Short-term and intermediate-range goals were then developed.

The initial thrust of the program was the distribution of wheat/soya blend, a U.S. Government P.L. 480 Title II commodity, repacked into one-and-a-half-pound packets to 42,000 nutritionally at-risk recipients through the Department of Health Services. The name Thriposha was used on each packet to give a national identification to the product and convey the triple nutritive value of the foodstuff. The intermediate goal of incorporating progressively-increasing portions of indigenous cereal to the imported commodity was planned to begin in mid-1974, with the government of Sri Lanka providing maize, sorghum and millet. A target formula of 20% local cereal to 80% WSB was envisioned.

EVOLUTION OF LEC ACTIVITY

In the summer of 1975, Mr. Paul R. Crowley was scheduled to visit Indonesia to discuss with CARE-Indonesia staff the planning for a LEC project. The CARE staff in Sri Lanka requested that Mr. Crowley stop in Colombo to explore whether an LEC system could be introduced to reach the production targets necessary to meet the requirements of the Thriposha program's beneficiary level, which was then 310,000. Mr. Crowley's visit to Sri Lanka concluded with a joint venture agreement reached whereby CARE would procure a Brady cooker, model 206, and the necessary ancillary equipment would be provided with funds from the United States Agency for International Development (USAID) through the United States Department of Agriculture (USDA). The Agricultural and Chemical Engineering Department of Colorado State University would design the extrusion facility and provide installation and start-up of the equipment and the training of personnel for this undertaking. Dr. Judson Harper and Mr. Ronald Tribelhorn from CSU spent 10 days in Colombo in July to design the extrusion plant and to determine the equipment to be ordered on their return to the United States.

The Brady and ancillary equipment arrived in Colombo late December, and by March 1976, the pilot plant was established in a grain milling factory in Kundasale 80 miles from Colombo. Mr. Ronald Tribelhorn assisted in the installation of equipment and trained operators in the management and maintenance of the machinery. A flow diagram of this plant is given in Attachments 1 and 1A.

The first twelve months of the pilot plant demonstrated the capacity of the LEC system to produce a nutritious food product acceptable to the target group of recipients. The formulation of cereal passed through the Brady extruder changed frequently; sorghum/soyabean, maize/soyabean and blends of maize/navy beans/coconut oil in various proportions were tested. The imported commodity to be blended with local cereals was also changed from WSB to Instant Corn Soya Milk to simplify the transition to the 100% indigenous product, as wheat is not grown in Sri Lanka.

An evaluation team (E.E. Kuphal, E.E. Gaylord and A.A. Ackels), sent by the USDA, reviewed the Kundasale operation in March 1977. The purpose of this delegation was to review the LEC operation in terms of suitability in the manufacture of cooked food commodities in developing countries and to assess whether the Sri Lanka installation adequately demonstrated the suitability for that purpose. Their conclusions, in brief, were that the LEC is suitable for use in developing countries with some refinements and that the Sri Lanka installation had not yet adequately demonstrated its capacity to produce nutritious foods with reliability, as measured in terms of meeting production schedules and production at low operating expense. The evaluation team left a set of recommendations which proved most useful for improvement of the Kundasale operation. Some of the problem areas found in this evaluation will be discussed in another section of this paper.

By 1978 the operating efficiency of the Kundasale plant had been improved, but the capacity to process local cereals to meet future production requirements, combined with the expense of transporting extruded cereals to Colombo for blending, necessitated a major relocation and expansion program. The Ministry of Health and CARE agreed to build a Thriposha processing complex to meet future program requirements on a seven-acre site 11 miles north of Colombo. The site selected in Kapuwatte was ideal, as it has direct access to both rail and main road transportation networks. The new complex, now under construction and scheduled for completion in April, will be adequate to handle the production of Thriposha for 600,000 recipients in a free distribution annually and the initial stage for a commercial marketing plan, scheduled to begin in September.

The new Thriposha processing complex will include under one roof storage facilities for raw materials and the finished product, a grain cleaning section, processing and packaging sections and a quality control laboratory. A flow diagram of this building is given in Attachments 2 and 2A. The heart of the LEC system is two electrically-powered Brady model 206's as modified by CSU. The ancillary equipment procured for the complex is given in Attachment 3. A lunchroom facility for the expected 150 employees and a garage for the seven Thriposha lorries are also now under construction, and plans for a second storage building are under consideration.

The plant operation and administration will be contracted to a third party with experience in the field of food processing and management. Under the terms and conditions of a contractual agreement, the third party will be responsible to produce an estimated 10,000 metric tons of Thriposha in the first year of operation. CARE and the Ministry of Health will establish the quality control standards to be maintained and the financial and material accountability systems to be implemented. The recruitment of potential parties to undertake the plant management is now underway, and we expect to select a candidate and sign a contract in mid-March.

PROBLEMS: PAST AND PRESENT/SOLUTIONS

In the first year of the Kundasale LEC operation the biggest problem encountered was the inability to meet production commitments. The evaluation team in 1977 commented that they were impressed with the LEC concept, but that the Kundasale system was not out of the "pilot plant stage and ready for dependable continuous production as a satisfactory commercial enterprise." Basically, the operating parameters of the equipment, spare parts requirements and a schedule of preventive and breakdown maintenance procedures were learned the hard way as the pressure for production increased.

Steady improvements were made in daily and monthly plant extrusion of local cereals as equipment operators grew with experience and maintenance performance of high quality developed. Attachment 4 shows the growth pattern of cereal utilization at the inception of the program to date. Production has ranged from a low of 195/332 kg. per operating hour in October 1976 to the high of 480.7 kgs. per operating hour for the period of July 1, 1977 to June 30, 1978. Assuming a rated capacity of 1,000 pounds/hour and actual working days planned of 208 @ 15 hours/day, the capacity of utilization of the plant was 85.4 in the above-mentioned period.

The development of a spare parts inventory requirement list, prepared by Colorado State University staff, and timely procurement have been instrumental in reducing the downtime of the plant. We are estimating that 10% of the equipment of the plant should be available in spare parts for the plant each year.

Comments by the USDA evaluation team in 1977 suggested that "inadequate maintenance is the cause of most of the lost operating time and parts failure." The recording of the cause of machine failure was inconclusive in illustrations given by the operators at Kundasale. Mr. Ronald Tribelhorn, in his many visits to Sri Lanka, has upgraded the skills and knowledge levels of the Kundasale personnel to make them sensitive to machine requirements for satisfactory long-life operation.

The availability of local cereals in sufficient quantities and of acceptable quality ha been and continues to be a constraint on the program. The quality of soyabeans and maize is directly associated with the storage practices employed outside the program's control. In 1976/77 the program fell short of soyabeans for production. The government of Sri Lanka established a floor price of US $0.17 per pound for soyabeans to encourage farmers to cultivate in 1978. The availability of soyabean has improved significantly. Unfortunately, maize production has declined, as farmers choose to plant paddy when there has been adequate rainfall. The program has fallen short of maize at present and has been forced to run on a limited production schedule for the past month. Our shortage of maize is attributed to inadequate storage by our supplier (Paddy Marketing Board) due to the heavy paddy yield in the past season. The government has instituted a building program for additional storage facilities to accommodate the unusually high crop yield.

Infestation of grain cereals has been minimized by implementation of scheduled fumigation and close supervision. Raw material sanitation will be greatly improved once the new Thriposha processing complex is completed and under the direct management of the program coordinators.

Power failures, although not a frequent problem now at Kundasale have contributed to downtime and were unavoidable. The new complex will be receiving its electricity directly from the national grid through the plant's own transformer.

PROGRAM RELATIONSHIP WITH GOVERNMENT OF SRI LANKA/OTHERS

The success of the Thriposha program LEC activity must be attributed to the financial and technical assistance received from a wide range of sources. Firstly, the Ministry of Health, under the auspices of the Family Health Program, whose objective is to improve the quality of life of women and children in Sri Lanka, has played an active role in the design of the program since its inception. The Ministry recently approved a five-year budget (1980-1984) to support the program targeted to reach 600,000 recipients in a free distribution of Thriposha by 1981. This assurance of project continuity and plan for the achievement of a completely indigenous product by 1988 has stimulated external participation and support.

The technical advice and material assistance provided through agencies of the United States Government have been significant. The USDA's Nutrition and Agribusiness Group has provided the program with its first spark and continue to provide technical support services through the availability of CSU personnel and private consultants in the areas of industrial management, grain handling/storage and marketing.

The procurement of PL480 Title II foodstuffs from the United States Government has been vital for the program to develop to its present level. To date, over 29,000,000 packets of Thriposha have been distributed to medically-selected recipients throughout Sri Lanka.

UNICEF has assisted the program through the procurement of six 5-ton trucks, which were supplied at a time of critical shortage of vehicles, for the transporting of raw materials and Thriposha. This contribution has reduced one program constraint to manageable terms.

Finally, there are not enough superlatives to adequately describe the efforts given and results obtained by the medical officers throughout Sri Lanka who are responsible for the selection of recipients and the allocation of Thriposha. Doctors, midwives, school teachers and volunteers have contributed countless hours of service to this vital end-of-the-line Thriposha channel.

SHORT-AND-LONG-TERM PROGRAM GOALS

The initial long-term goal of producing a 100%-indigenous food product still remains in the forefront of the program. With increasing program support by the government of Sri Lanka this target is expected to be attained in 1988. Domestic input in the form of local cereals has been on the increase since the inception of the program, while the imported PL 480 commodity inputs have remained at a constant level and will begin a phased decline in 1981 as shown in Figure 1.

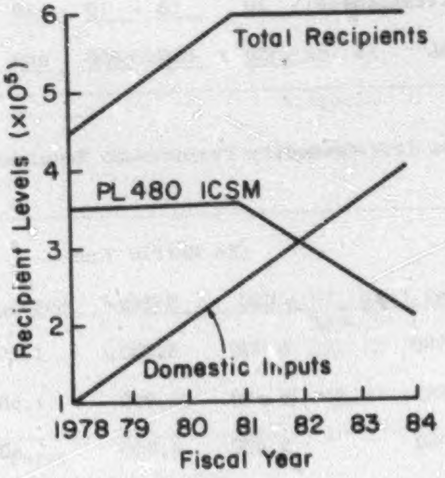


Figure 1. Commodity/recipient level FY1978-84.

Recipient levels, having begun at 42,000 in 1972, will rise to a ceiling of 600,000, considered to be the maximum effective level to which Thriposha can be distributed through the Ministry of Health MCH infrastructure. For this reason and the known statistic that malnutrition of pre-school children may be as high as one million, a commercial plan for Thriposha has also been followed to date. Commercial sales will begin in September, and a realistic projection of volume will be determined during the eight-month trial.

The following table shows the targeted recipient levels of Thriposha receiving a monthly ration of 1.5 kilos (Table I).

The availability of maize and soyabeans remains crucial to the attainment of short-term and long-term production goals. The program's commodity requirements, in line with the recipient levels given above, are detailed for the next five-year period (Table II).

Table I. Target Recipient Levels of Thriposha

	FY80	FY81	FY82	FY83	FY84
			(in Thousands)		
Medical Centers, Health Stations and Estates	440	490	490	490	490
Primary Schools	100	100	100	100	100
Social Service Institutions	10	10	10	10	10
TOTAL	550	600	600	600	600

Table II. Commodity Procurement Requirements

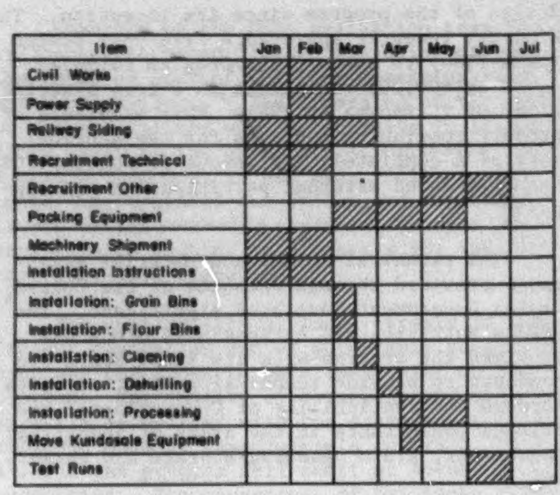
(in Metric Tons)

Fiscal Year	ICSM	Maize	Soyabeans
1980	6,300	3,200	1,200
1981	6,300	4,000	1,500
1982	5,400	4,800	1,800
1983	4,500	5,600	2,100
1984	3,600	6,400	2,400

A recently-completed railroad siding services the new plant.

The evolution of farming systems in Sri Lanka has brought about a change in the traditional demarcation between rice as a dominant crop and other field crops as subsidiary. The production of highly nutritious varieties of grains such as maize, sorghum, millet, cowpea, gram and soyabeans is now well-established and is gradually developing into a regional specialization. The program is confident that government, through the Agricultural Productivity Law, will meet the food production targets far in excess of our requirements.

Figure 2 describes the schedule of activities and time frame required to accomplish the transition from the Kundasale plant to the Thriposha processing complex in Kapuwatte.



Item	Jan	Feb	Mar	Apr	May	Jun	Jul
Civil Works	▨	▨	▨				
Power Supply		▨					
Railway Siding	▨	▨	▨				
Recruitment Technical	▨	▨					
Recruitment Other					▨	▨	
Packing Equipment			▨	▨	▨		
Machinery Shipment	▨	▨					
Installation Instructions	▨	▨					
Installation: Grain Bins			▨				
Installation: Flour Bins			▨				
Installation: Cleaning			▨				
Installation: Dehulling				▨			
Installation: Processing				▨	▨		
Move Kundasale Equipment				▨			
Test Runs						▨	

Figure 2. Implementation schedule for plant.

CONCLUSION

The LEC activity, from the Kundasale plant to the new Thriposha processing complex, has supported the focus of the program of reducing the incidence of malnutrition in Sri Lanka by supplementing inadequate diets. The problems encountered along the way have been significant in number but have been resolved through the tapping of technical and management services affiliated with the program. Recognition of the important roles played by Mr. Paul R. Crowley of the USDA's Nutrition and Agribusiness Group and his co-workers and Dr. Judson M. Harper of Colorado State University and his associates in the success of the promotion of LEC systems in developing countries must be given.

The LEC system in Kundasale has proved cost-effective as shown by the data given in Tables III, IV and V. Most recent calculations have shown that a pound of Thriposha can be produced and packed for U.S. $0.15. The coordinators of the program agree that improvements can be made to produce a better product within the financial capabiliites of a developing country to support.

Table III. Production Costs

Line Item	Total Quantity Obtained or Produced	Quantity Losses	Unit Prices	Total Price
1. Raw Materials				
A. Corn	1,034,513 Kg.	96,769 Kg.	0.1048	108,406.96
B. Soybean	298,991 Kg.	27,982 Kg.	0.4267	127,579.45
2. Packaging Materials				
A. Gunnies	N.A.[1]	-	-	-
B. Poly Liners	26,648	-	0.0733	1,952.35
3. Production				
A. Kundasale Processing	1,208,753 Kg.	-	[2]	25,904.86
1. Management	-	-	-	1,526.45[3]
2. Labour	-	-	-	(706.45)
3. Other	-	-	-	(791.23)[4]
B. Transport	1,208,753 Kg.	-	0.0043	5,157.63
C. Maintenance	-	-	-	1,324.26
D. Spare parts (Total only; could list by item if you wish)	-	-	-	4,038.45*
E. Direct Costs				
1. Fuel	38,679 L.	-	0.0781	3,021.45
2. Lubricants	-	-	-	383.39*
3. Electricity	57,124 kWh	-	0.0097	552.77
4. Cost of Production Total	-	-	-	279,848.02

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[1] Gunny bags supplied without cost by Paddy Marketing Board

[2] Cleaning cost per kilogram 0.0142; processing cost per kilogram 0.0043

[3] CARE-managed staff salaries

[4] Permanent/temporary labour salaries managed by Cereal Products Factory not included as covered in processing expenses

* Separate breakdown given in Table IV.

In conclusion, you are most cordially invited to visit the new Thriposha processing complex in Sri Lanka, and I would welcome the opportunity to open dialogues to exchange information on this program with you.

Table IV. Capital Costs

Line Item	Unit Price	Serviceable Life	Hrs/year	Unit Cost $/hour
1. Equipment				
A. Bulk Tanks	1,905	10 yrs.	2,514	0.07757
B. Cummins Diesel	10,000	10 yrs.	2,514	0.39777
C. Brady	5,000	10 yrs.	2,514	0.39777
D. Cooler	7,600	10 yrs.	2,514	0.30230
E. Prater	3,100	10 yrs.	2,514	0.12330
F. Modern Mill	4,100	10 yrs.	2,514	0.16308
G. Screw Conveyors	3,800	3 yrs.	2,514	0.50384
H. Electrical	2,250	10 yrs.	2,514	0.08949
2. Installation Cost				
A. Labour) B. Material) C. Other)	2,940.68	10 yrs.	2,514	0.11697
3. Technical Assistance Costs*		10 yrs.		
A. Planning of plant-30 days	6,000	10 yrs.	2,514	0.23866
B. Installation, Training and Start-up-30 days	4,500	10 yrs.	2,514	0.17899
C. Technical Back-stopping-80 days	12,000	10 yrs.	2,514	0.47732
4. Total Direct Plant Costs	63,240.68	--	—	3.06706

*Based on consulting services of $150/day/consultant. Only charge is made which is related directly to plant logistics and peculiar to Kundasale. Estimate by CSU.

Table V. Summary

Line Item	$/hour Unit Cost	Average Production per hour	Cost/Kg.
1. Total production cost	111.32	480.81 Kg.	0.2315
2. Total direct plant costs	3.07	480.81 Kg.	0.0064

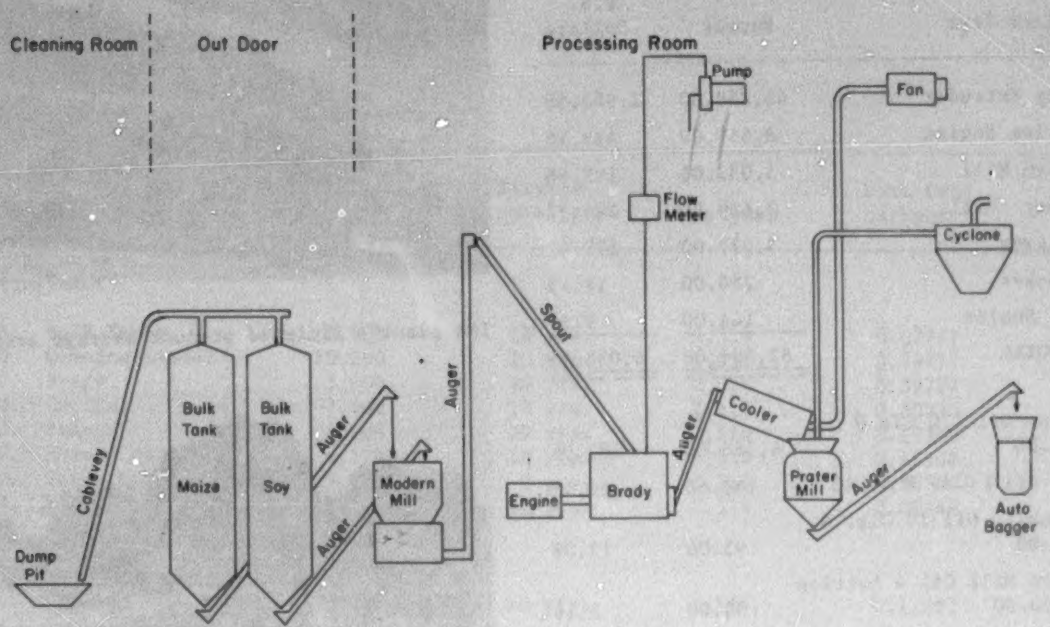
Table VI. Breakdown of Spare Parts

Line Item	Rupees	U.S. Dollars
Brady Extruder	45,858.00	2,958.58
Cummins Engine	6,559.00	423.16
Modern Mill	3,033.00	195.68
Prater Mill	3,639.00	234.77
Cableway	3,077.00	198.52
EP Auger	286.00	18.45
Heat Sealer	144.00	9.29
TOTAL	62,596.00	4,038.45
Engine Oil 170 Gls @ 25.80	4,386.00	282.96
Gear Oil 4 Gls. @ 40.40	161.60	10.43
Hydraulic Oil 10 Gls. @ 95.00	195.00	12.58
Modern Mill Oil 4 bottles @ 20.00	80.00	5.16
Grease 140 lbs. @ 8.00	1,120.00	72.26
TOTAL	5,942.60	383.39

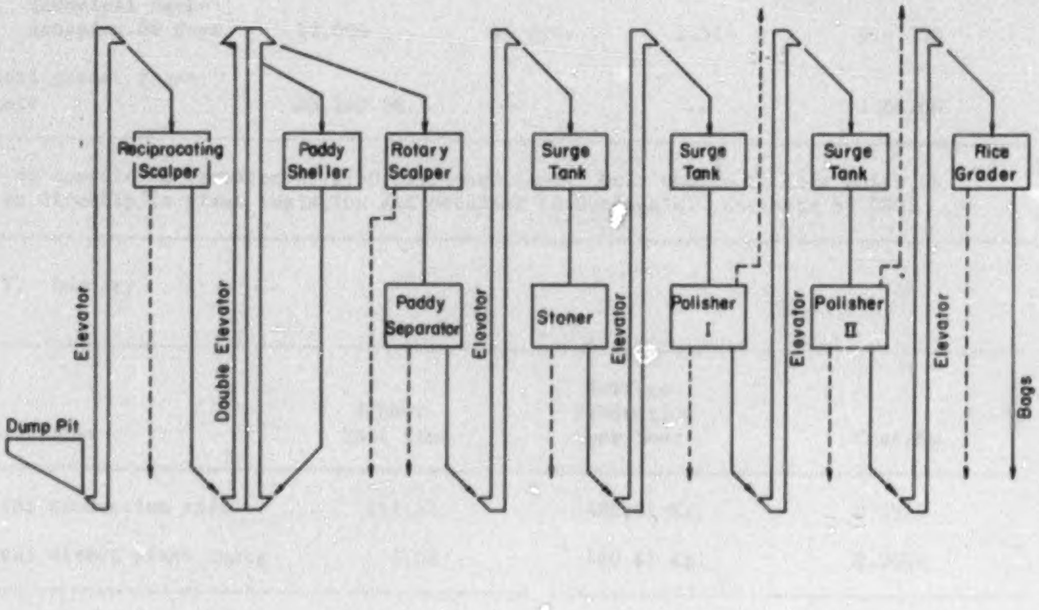
The plant's finished product storage area.

The building with lunch and restroom facilities is nearing completion.

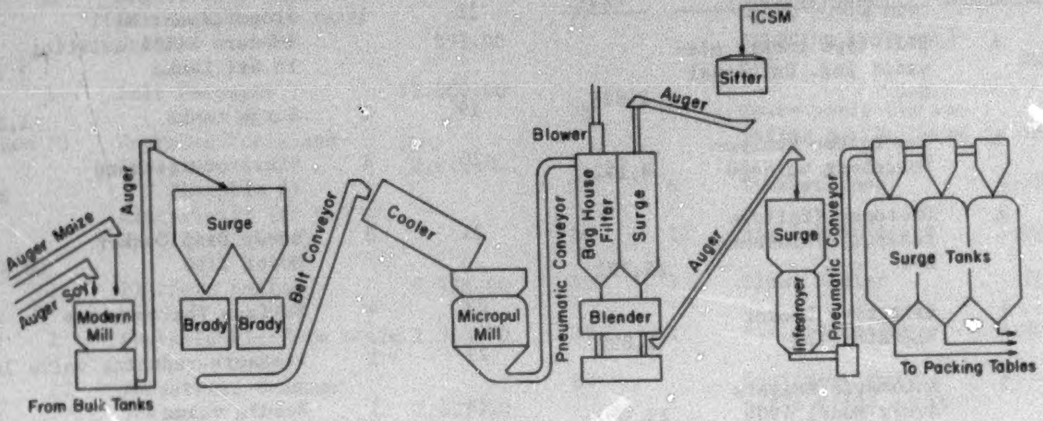
ATTACHMENT 1 THRIPOSHA PLANT, CEREAL PRODUCTS FACTORY, KUNDASALE


Cleaning Room
Out Door
Processing Room
Pump
Fan
Flow Meter
Cyclone
Spout
Bulk Tank Maize
Bulk Tank Soy
Auger
Auger
Auger
Auger
Cooler
Auger
Modern Mill
Cablevey
Dump Pit
Engine
Brady
Prater Mill
Auto Bagger

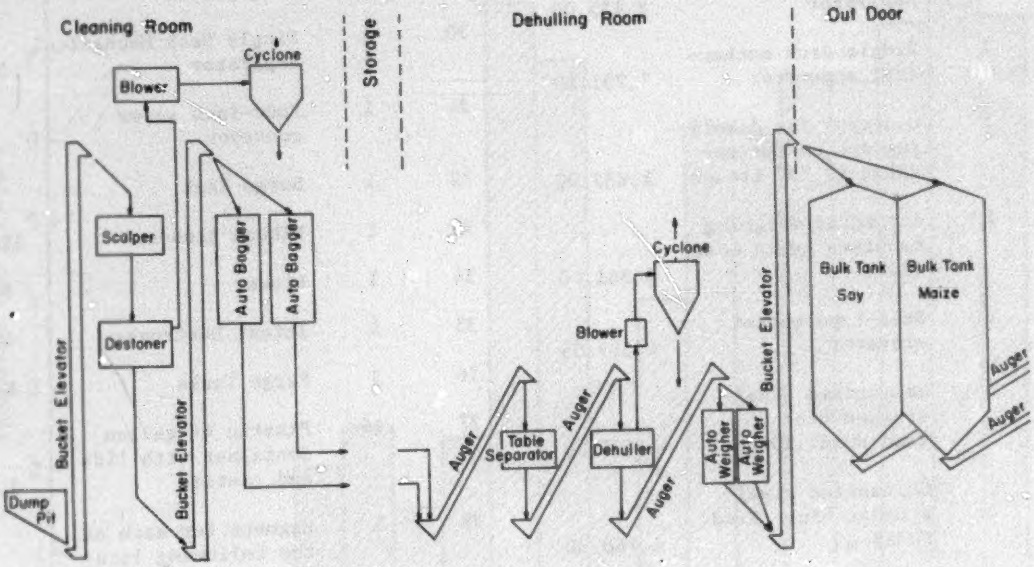
ATTACHMENT 1A SHULE ONE-TON RICE MILL FOR CLEANING MAIZE AND SOY, CPF, KUNDASALE


Reciprocating Scalper
Paddy Sheller
Rotary Scalper
Surge Tank
Surge Tank
Surge Tank
Rice Grader
Paddy Separator
Stoner
Polisher I
Polisher II
Elevator
Double Elevator
Elevator
Elevator
Elevator
Elevator
Dump Pit
Bags

ATTACHMENT 2 PROCESSING SECTION, PROPOSED THRIPOSHA PLANT, JA ELA


ICSM
Sifter
Auger
Blower
Bag House Filter
Surge
Auger
Surge
Infestroyer
Pneumatic Conveyor
Surge Tanks
To Packing Tables
Auger Maize
Auger Soy
Auger
Surge
Modern Mill
Brady
Brady
Belt Conveyor
Cooler
Micropul Mill
Pneumatic Conveyor
Blender
From Bulk Tanks

ATTACHMENT 2A CLEANING-STORAGE-DEHULLING, PROPOSED THRIPOSHA PLANT, JA ELA


Cleaning Room
Storage
Dehulling Room
Out Door
Blower
Cyclone
Scalper
Destoner
Auto Bagger
Auto Bagger
Bucket Elevator
Bucket Elevator
Dump Pit
Auger
Table Separator
Auger
Dehuller
Blower
Cyclone
Auger
Auto Weigher
Auto Weigher
Bucket Elevator
Bulk Tank Soy
Bulk Tank Maize
Auger
Auger

ATTACHMENT 3

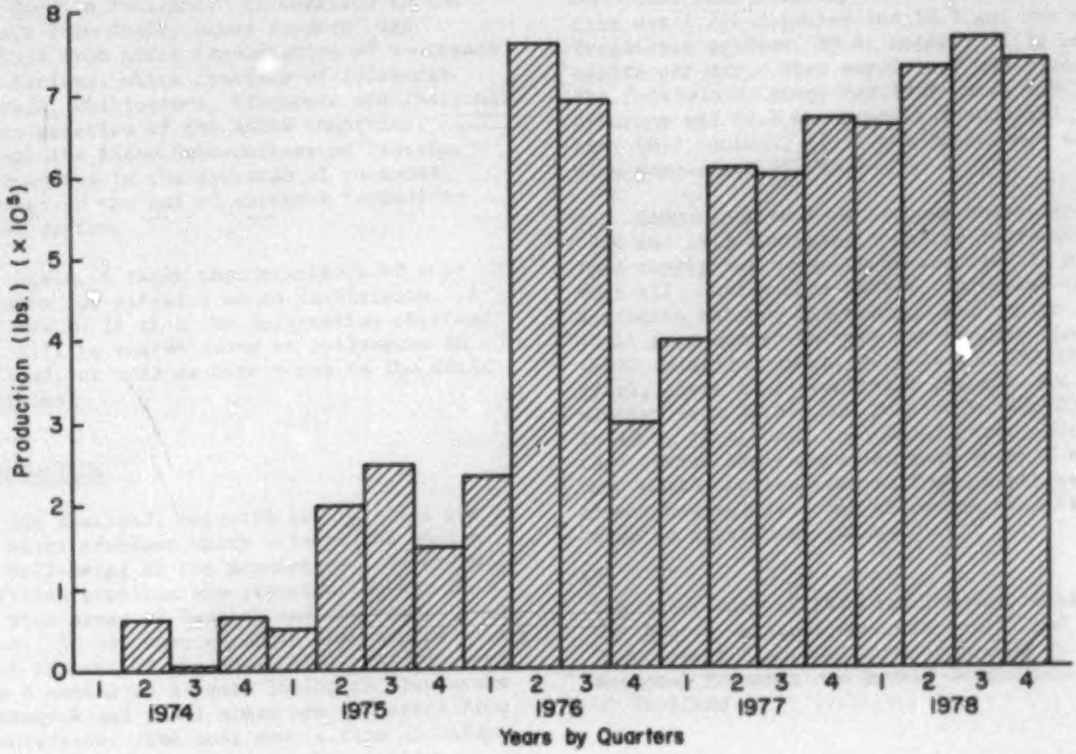
CLEANING SECTION

Item	Quantity	Description	(U.S.) Cost
1	1	Belt-type bucket elevator leg. Universal C-2	1,835
2	1	Two-screen scalper Forseberg 60/8400	9,192
3	1	Destoner (follows scalper) Forseberg H-8	15,772
4	1	Belt-type Bucket Elevator leg	1,829
5	3	Automatic Baggers Avery Model 4904	23,309
		DEHULLING SECTION	
6	1	Four-inch diameter screw-type conveyor	298.80
7	1	Vacuum Gravity Table Separator	9,164
8	1	Four-inch diameter screw-type conveyor	338.70
9	1	Sturtevant No. 3 Scourer/huller aspirator	8,155.00
10	1	Single deck mechanical separator	1,751.00
11	1	Conveyor for dehulling system two-way valve 8" "U" trough	1,652.00
12	2	Automatic weighing machines Avery model 4901	6,361.00
13	1	Belt-type bucket elevator	4,597.05
14	1	Galvanized steel storage bin: Read Model 10	1,345.00
15	1	Galvanized steel storage bin: Read Model 25	1,780.00
16	2	Discharge boots for items 14 and 15 (cost included in items 14 and 15)	
		PROCESSING SECTION	
17	2	Four-inch diameter screw-type conveyor	724.60
18	1	Proportioner Mill (Modern Mill) existing in Sri Lanka	3,736.00
19	1	Surge tanks	1,500.00
20	4	Vibratory feeders (4 ordered)	972.00
21	2	Brady Crop Cooker Model 2160	10,658.00
22	4	Surface Thermometers	65.00
23	1	Pressure-reducing valve	160.00
24	1	Needle valve	39.30
25	1	Rotameter	233.00
26	1	Belt Conveyor	7,930.00
27	1	Finished Product (existing in Sri Lanka) Dorsey-McComb oven	10,605.00
28	1	Reduction Mill	9,890.00
29	1	Surge Tank	500.00
30	1	Single Deck Mechanical Separator	5,000.00
31	1	Four-inch screw conveyor	300.00
32	1	Surge Tank	924.00
33	1	Ribbon Blender	19,897.20
34	1	Blower	9,054.00
35	1	Infest Destroyer	4,445.00
36	3	Surge Tanks	6,000.00
37	16	Plastic 44-gallon container with lids and castors	1,000.00
38	3	Magnets for each of the following locations 1. Inlet to the Sturtevant 2. (2) Outlet of the proportioner mills 3. Outlet of final blender (stainless)	390.00

ATTACHMENT 3 (Continued)

Item	Quantity	Description	Cost
39	1	Magnet flat plate type for location in mill inlet	551.00
40	1	Belt Conveyor	12,000.00
41 thru 70		Workshop Tools and Equipment	2,910.00
71		Electricals (to be specified later)	
72	2	Platform Scales	2,438.00
73	2	Portable Platform Scale	1,363.00
74	12	Industrial Counter Scales	2,621.00
75	1	Industrial High-Pressure Cleaner	2,973.00
76	6	12" Heat Sealers: Sergeant Model 312	2,000.00
77		Spare parts for existing heat sealers	585.00
78		Spare parts for existing Bay Stitcher	361.00
79	8	Exhaust fans	4,053.00
80	12	Air Conditioners	5,028.00
81	1	Floor Sealer	747.00
82	1	Air compressor	1,350.00
83		Equipment spare parts @ 10% equipment cost	
84		Crating and Inland freight @ 6%	

ATTACHMENT 4 LOCAL CEREAL UTILIZATION



LEC Activities in Thailand

Prof. Amara Bhumiratana
Institute of Food Research and Product Development
Kasetsart University
Bangkok, Thailand

First of all, I would like to sincerely thank Colorado State University (CSU) and USAID for inviting me to participate in the Second International Low-cost Extrusion Cooker (LEC) Workshop in Tanzania. This workshop has allowed me the great opportunity to meet and talk with numerous scientists involved in the area of extruder technology. The detailed comments and suggestions obtained in this workshop will undoubtedly be of much help to us in developing extruder technology in Thailand. I regret that I was unable to attend the first workshop on this topic in 1976.

Special thanks must be paid to the USAID, which has assisted Thailand on two related projects, namely, "Protein Food Promotion" and "Protein Food Development," from 1969 to 1971 and from 1971 to 1974, respectively. Furthermore, at this moment USAID is considering support of another project dealing with the problem of distribution of high-protein, low-cost food in Thailand. In addition to the support from USAID, other support was received from ASEAN (Association of Southeast Asia Nations, which consists of Indonesia, Malaysia, Philippines, Singapore and Thailand). The cooperation of the ASEAN countries, through the ASEAN Subcommittee on Protein, has resulted in the exchange of personnel and data on the use of extruder technology in the region.

Again, I thank the organizers of this workshop for allowing me to participate. I will see to it that the information obtained here will be shared among my colleagues in Thailand, as well as with those in the ASEAN countries.

INTRODUCTION

In Thailand, malnutrition is still one of the major problems which affects the health and well-being of the population. Severe malnutrition problems are prevalent mostly in the slum areas of Bangkok and the remote rural areas. It has been reported that approximately 52-76 percent of the pre-school children aged from 6 months to 5 years living in slum areas of Bangkok and rural areas are suffering from malnutrition. The most severe type of malnutrition that is reported is the protein-calorie malnutrition, which occurred among infants, pre-school children, schoolchildren and pregnant and lactating women. The causes of the malnutrition problem are, of course, multiple. The lack of sufficient income to buy high-quality foods, the unavailability of high-quality food products, the poor distribution of food and eating patterns and habits are the main causes which contribute to it.

CAUSES OF MALNUTRITION PROBLEMS IN THAILAND [1]

Population Growth and Food Production

Malnutrition will occur if food production falls behind population growth. It is clearly shown in food balance sheets of 1966 and 1972 that food supply for the demand of domestic consumption has not been increased during the period.

The FAO food balance sheet (1966) indicates that food available for domestic consumption was 2,226 calories and 50.9 gm. protein (vegetable sources, 38.6; animal, 12.3) per capita per day. Rice supply was 442.5 gm. The food balance sheet for 1972 shows 2,579.5 calories and 57.8 gm. protein (vegetable sources, 40.3; animal, 17.5) per capita per day. Rice supply was 482 gm.

Comparison of food balance sheets for 1966 and 1972 indicates that the increase in food supply for domestic consumption is almost nil during this period. Although the aggregate balance and average per capita are still good enough to meet the average demand (1920 calories, 38 gm. protein and 350-400 gm. rice), there is a remarkable increase in population from 31,955,000 in 1966 to 38,577,000 in 1972, or about 3.1-3.2% per year. During this period the population grew about 7 million while the increase in food supply was almost negligible. The situation will be worse in subsequent years.

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[1] The major part of this section was taken from the Fourth National Economic Social and Development Plan, which was prepared by the National Economic and Social Development Board of Thailand.

In 1978, the total population in Thailand was estimated at 45.2 million. The numbers in the most vulnerable groups were as follows:

Children 0-4 years of age	8 million
Children 5-14 years of age	13.5 million
Pregnant women	0.9 million

These three groups will suffer most from malnutrition if there is inadequate increase of food supply and nutrition policy is not recognized in the national planning of agricultural production.

From the figures of food availability in the food balance sheet of 1972, one might think that Thailand had enough food and that the Thai people should not have suffered from malnutrition. But the fact is that the food does not reach the consumers for full utilization.

Family Income

Family income has a close relationship to diets. It determines the family's food expenditure in middle-and low-income families. The family's diet is not automatically better with a higher income, though consumption of meat and milk products, fruits and vegetables increases eventually. In fact, there may be a range of income in which substitution of processed foods and high-cost nutrients for the subsistence diet actually reduces family nutritional status.

The family in the municipal areas spends an average of 47.72% of income per month for food, while in the rural area 48.43% is spent. These averages conceal the fact that families with very low incomes often spend 90% or more on food.

Family income usually derives from two sources, visible and invisible. The visible income includes salary, wages and net profit from business, while the invisible is the income which can not be calculated by monetary value and usually forms a larger part in the rural economy than in the urban. Data show that average invisible income of the whole population is 38.1% of the total visible income for the rural and 5.3% for the urban. The highest is among the population of the Northeast, 76.1%, while in the North it is 45.7% and 14.8% in the Central.

In consideration of nutrition problems in the population, these two sources of income have been combined and compared with least-cost expenditures on food the family needs to fulfill minimum requirements. Formulations of least-cost diets for a family of six have been prepared, based on the quantity of food "needed by the family," its nutritive value and the cost. Following is a summary of the calculation.

Minimum food requirement for a family of six, including father, mother, 3 children (ages of 6, 4 and 3 years) and 1 old woman is as follows:

total calories	9,710.0
fat	219.0 gm. or 20.4% of total calories
carbohydrate	1,708.3 gm. or 70.4% of total calories
protein	223.6 gm. or 9.2% of total calories

Expenditures for various categories of food to make three meals, using average prices during 1972-1973, is Bahts 20 per day, or Bahts 7,300 per year. 2/ Only foods regularly consumed in Thai diets were included. Taking 50% of the total income as an average expenditure for food, annual total income of the family required to buy enough food will be Bahts 14,600.

In applying the above findings, it can then be assumed that any family with an annual income below Bahts 12,000 is at a poor level of nutrition. According to the statistics, this includes 61.1% of all families in rural Thailand. At least 3% of urban families are also below this level. Regional distribution is as follows:

Northeast	municipal areas	1.2%
	rural	76.3%
North	municipal areas	2.4%
	rural	68.7%
South	municipal areas	3.7%
	rural	68.2%
Central	municipal areas	2.2%
	rural	51.7%

In reviewing the relationship of income to nutrition, it is important to recognize that family income adequate to produce or purchase satisfactory nutrition status for all family members does not assure that each individual will be properly fed. Distribution practices within the family often lead to malnutrition among young children, even in higher-income groups.

In summary, Thailand has a number of families in the regions which cannot afford to buy enough food to fulfill minimum requirements:

2/ 1 $ US = Baht 20.

Whole country	64.1%
Northeast	77.5%
North	71.1%
South	71.9%
Central	53.9%

Eating Habits and Patterns

Eating patterns of the people usually vary according to the community's ecology as well as tradition. The urban community has different patterns and habits of eating than those of the rural area. The income of the family and the nutritional knowledge of the members also designate the quality of food prepared. Generally, meal patterns consist of cooked rice consumed with "Kaeng" or "Nam Prick," vegetables and a small amount of protein food such as fish, meat or egg. The protein food is usually considered an appetizer instead of the main item of the diet. This type of meal constitutes a low-fat diet.

In the rural areas, traditional beliefs and food taboos are widespread—especially among pregnant and lactating women—and contribute to poor habits of eating. For example, pregnant women are not allowed to eat meat. Also, prohibition of certain kinds of food is practiced after delivery of babies.

Food Distribution

There are several locations in Thailand, especially in the Northeast, where the land is arid and poor, yielding low food production insufficient even for family consumption. The remoteness and isolation of the areas cause failures of food distribution. Malnutrition is quite common among the people, as is evident in the reports of the mobile medical units.

The marketing system and distribution of foods cause nutritional gaps. Frequently, foods do not reach consumers at reasonable cost. The roles of middlemen, exporters, and the undeveloped transport system, as well as the lack of facilities, are mainly responsible for the higher price of foods. Rice shortage, for instance, has occurred almost every year in spite of the aggregate balance which appears in the statistics. The same problem is applied also to other food commodities, particularly the protein foods whose frequent shortage and higher prices cause much trouble among the low-income groups of population. The following factors are involved:

1. The policies on production and domestic consumption are not coordinated. Food producers are always interested only in the amount of profit, thus neglecting the needs of the consumers.
2. Hoarding by merchants causes shortages and high prices of food.
3. Over-exporting legally and illegally.
4. Improper marketing system results in too much difference between production cost and retail price.

THE USE OF EXTRUDED PRODUCTS IN SOLVING MALNUTRITION PROBLEMS IN THAILAND

Food and Nutrition Policy

1. Develop better health of all segments of the population to lower the morbidity and mortality rates, to increase working capacity and productive years by improvement of nutritional status of the population; and to develop programs within the health care system that will prevent and rectify nutritional problems.

2. Assure an adequate food supply to meet the nutrition needs of all segments of the population by improving food production programs for nutritious foods. This supply will be available for consumption at reasonable cost.

3. Assure an adequate food supply for the nutritional benefit of domestic consumers by developing an appropriate system of distribution, transportation, marketing, storage, import and export of food commodities.

4. Develop at all levels sound knowledge and understanding of food and nutrition that will promote maximal nutritional health by strengthening programs for nutrition education both in the school curriculum and for the general public.

5. Maintain a system of quality and safety control of food supply for the benefit of the consumers by strengthening food control measures, food sanitation and personal hygiene standards.

6. Raise social and economic standards for all segments of the population, thereby contributing to the development of food and nutrition by promoting various occupations for higher income.

7. Support research in food and nutrition and nutrition education and set reasonable priorities to solve important current problems which will permit basic research that can be implemented.

THE PRODUCTION OF EXTRUDER PRODUCTS

The Wenger X-25 Extruder

History - Within the Protein Food Development Project (1969-1971) and the Protein Food Promotion Project (1971-1974), carried out by DTEC on behalf of the Thai Government and by USAID on behalf of the U.S. Government, the Institute of Food Research and Product Development (IFRPD), Kasetsart University, undertook research and development work to produce high-protein, low-cost foods. The Division of Nutrition, Department of Health, undertook evaluation work and actual field trials and distribution, and the USAID contributed a Wenger X-25 extruder in 1972 which was installed by Wenger's engineer and IFRPD's engineering staff.

Background - In 1971, USAID provided four-months' training programs for IFRPD's staff. Three staff members were sent for training at the United States Department of Agriculture, Northern Marketing and Nutrition Research Division, Peoria, Illinois, to take the "Soybean Products" training program. After the programs were finished, the sponsor provided an additional program to train at Wenger Manufacturing Co., Sabetha, Kansas. Though scheduling difficulties prevented this program from being as effective as it might have been, the trainees did learn the theory and main principles of cooker-extruders in general. (Regrettably, there was no specific focus on the Wenger X-25 extruder.)

After the training programs ended in January 1972, the staff was supposed to operate the extruder; however,the machine was not completely installed, and USAID was requested to send Wenger's engineer to complete installation and start test-operating it. While Wenger's engineer, Mr. C. Kenzi, was at the institite, rice was run 2-3 times and during his visit it was learned that not all parts of the machine were functioning correctly. As a result, it was necessary for the institute to repair some elements of the electrical system.

Rice was the raw material used for the experimental trials to determine the operating parameters of the machine and its components, i.e., screw, head, steam lock, feeding capacity, etc., and ingredient characteristics such as moisture and temperature. The experimental trials failed many times, sometimes after only a 5-10-minute operation, because gelatinized rice samples plugged the outlet. With the malfunctioning of the machine, the electricity sometimes shut off. The basic problems as reported to the institute were:

a. The operators were not qualified enou by knowledge and skill to operate the extruder.

b. Lack of manual information about various products not simply processed. Even though Wenger's engineer had written that this is not a simple pro cess, nothing could be read in the bo that specifically stated all the variables. Knowledge and know-how had "come from experiences and the indiv dual company's internal research and development programs."

c. Lack of trained personnel in this are and difficulty in training them in a short time. It needed personnel who had experience and basic engineering knowledge.

In 1973-1975, the Australian Government gave assistance to help the institute set up baby food project. Dr. R. A. Buchanan was the project leader, the details of the project we laid out and the required ancillary equipment was contributed by the Australian Government, i.e., mixer, grinding machine, etc. The project called for the use of the Wenger X-25 extruder to produce baby food consisting of a combination of rice, soybean, sugar, salt, sesame, vitamins and minerals. The baby food experiments had been formulated based on the nutritional requirements of infants. The Wenger X-25 extruder had been operated sufficiently to find the most suitable conditions, even though at the beginning of 1974 the experiments did not quite succeed because the products were not fully puffed. The formulas for the experimental trials are shown in Table I.

Due to the hard work of the staff operators the completed baby food formula was successfully processed on May 20, 1974. The ingredients of the baby food are shown in Table II.

The set-up of the Wenger X-25 extruder for producing the baby food formula is show in Table III.

Operation - All ingredients were complet ly mixed and water was then added to the mix ture in the extruder hopper. No steam was used. After suitable conditions were obtaine the extrudate was well-puffed. The machine was capable of producing 54 kg in 21 minutes machine operation. With this success, additi al techniques were tried on the machine an in mixing operations, including elimination o the mixing of ingredients with water. The ex periments had developed output capacity rangi from 50 to 300 kg. At the present time, the capacity of this extruder is around 250 kg pe hour, and the production at IFRPD amounts to about 1,500-1,600 kg per day.

Table I. Baby Food Formulae for Experimental Trials On Wenger X-25 Extruder

	1	2	3	4	5	6	7	8	9	10	11	12
Rice flour	650	650	685	685	635	735	500	460	446	480	685	720
Dehulled sesame	120	120	130	130	135	135	135	-	-	-	-	-
Full-fat soy flour	70	70	75	75	70	70	140	155	145	145	105	125
Sugar	100	100	150	150	150	50	300	300	350	300	150	150
Banana	50	100	-	-	-	-	-	-	-	-	-	-
Iodized salt	2	2	2	2	2	2	2	2	2	2	2	2
Tricalcium phosphate	1.8	1.8	3	2.5	2.5	-	-	-	-	-	-	-
Ferroc ammonium citrate	0.2	0.2	-	-	-	-	-	-	-	-	-	-
Lactose	5	5	5	5	-	5	-	-	-	-	-	-
Coconut oil	-	-	-	-	-	-	55	80	54	70	55	-
DL. Methionine	-	-	-	-	-	-	-	-	-	-	0.5	0.5
Calcium hydroxide	-	-	-	-	-	2	2	2	2	2	2	2

The formula with sesame has the following composition:

Rice	64%
Soy	7.0%
Sesame	13.4%
Sugar	15.0%
Salt	0.2%
$CaCO_3$	0.3%
Vitamin	0.1%

Table II. Baby Food Formula from IFRPD

Rice flour	70.85%
Full-fat soy flour	12.5%
Sugar	15.0%
Mixed vitamins	1.0%
$CaCO_3$	0.4%
Salt	0.2%
Methionine	0.05%

While the experimental trials of the Wenger X-25 extruder were continuing, the institute requested the USAID Mission in Bangkok to appoint Dr. D. F. Owen as an advisor from July 15-26, 1974. Until that time only the baby food formula had been produced by the Wenger X-25 extruder. The purpose of Dr. Owen's consultation was to aid the Thai personnel involved in the operation of the Wenger X-25 in:

a. The production of an infant food (to avoid confusion with a more complex infant formula, I shall refer to this as a weaning food).

b. High-protein product development.

c. The cooking of full-fat soy flour.

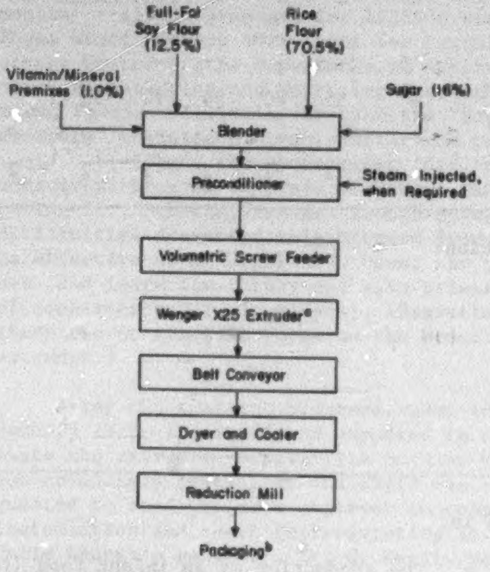
After Dr. Owen left, the staff operators continued to learn by running the X-25 and gradually acquired more experience with the machine and extruded products.

The commercial sale of an extruded product, baby food, started at the beginning of 1975. The Dumex Company ordered 160 tons of baby food for delivery to Vietnam. In this same year, one of our staff, Mr. Pracha Boonyasirikool, who was in charge of the extruder operators, obtained a scholarship to train in "Soybean Processing for Food Uses"

Table III. The Wenger Extruder Set-Up for IFRPD's Baby Food Formula

Screw	#1	#2	#3	#4	#5	
Screw	28329-1	28326-1	28326-1	28326-1	28385-3	(S)
Head	28366-1	28318-1	28318-1	28318-1	28350-1	-
Steam lock	28364-1	28324	28364	28386	-	-

at the University of Illinois. Additional training was received at the Wenger Manufacturing Company in Sabetha to gain more experience with extruders. By now, the institute had developed its own scheme (Figure 1) to produce baby food for infant feeding in Thailand and elsewhere in Southeast Asia.



[a] Residence time: 20-40 sec.
Final temperature: 90-100°C
Five zones: 1 & 5 cooling; 2, 3, and 4 heated steam

[b] 500 g per plastic bag.

Figure 1. Scheme of IFRPD baby food production system.

The Promotion of Baby Food Production

October 1973-September 30, 1974:

Period of start-up and development; production was about 50-60 tons.

October 1974-September 30, 1975:

Produced for Ministry of Public Health 120 tons.

January 1975-September 30, 1975:

Produced for Vietnam (Dumex Company) 160 tons.

October 1975-September 30, 1976:

Produced for Ministry of Public Health and retail market 131 tons.

October 1976-September 30, 1977:

Produced for Ministry of Public Health and retail market 146 tons.

October 1977-September 30, 1978:

Produced for Ministry of Public Health and retail market 180 tons.

Besides the baby food product, the institute had developed a high-protein snack made on the Wenger X-25. Both the baby food and the high-protein snack had been sent to Malaysia and other countries under the Association of Southeast Asian Nations' (ASEAN) Protein Project. Now the high-protein snack is being produced for sale in the retail market in Bangkok to test acceptability and feasibility. The process of the high-protein snack is similar to that of the baby food product, the only difference being the component configurations and the use of steam to heat the outlet head. The institute had developed the various formulas of the best high-protein snacks which are shown in Tables IV, V and VI.

Table IV. High-Protein Snack Formula at IFRPD

Wheat flour	20	kg
Rice flour	22.40	kg
Sugar	1.0	kg
Salt	900	gms
Mixed Vitamin & Minerals	500	gms
Chili Pepper	120	gms
Seasoning Agent	90	gms
Food color	15	gms

Table V. High-Protein Snack (For supply to Malaysia)

Wheat flour	36.11 %
Rice flour	42.11 %
Full-fat soy flour	13 %
Fish protein concentrate	2.5 %
Salt	2.4 %
Sugar	2.4 %
Mixed Vitamin & Mineral	1.0 %
Chili pepper	0.25%
Seasoning agent	0.20%
Food color	0.03%

Table VI. High-Protein Snack (For market testing)

Full-fat soy flour	20 %
Salt	1 %
Chili pepper	0.1 %
Seasoning agent	0.20%
Mixed Vitamin & Mineral	1.0 %
Rice flour	79.67%
Food color	0.03%

(This formulation has the best texture and best taste after flavoring.)

In order to make the high-protein snack more attractive, the 3-kg bland taste snack was sprayed with 7-10% vegetable oil and 3% flavor such as seafood flavor, chicken flavor and barbecue flavor. The flavor-cooked products were then dried in a continuous dryer at 100°C for 15-20 minutes and finally packed in a plastic bag.

Conclusion

As far as the progress of research on the extruder is concerned, the pace seems too slow for the following reasons:

a. Not many people are engaged in this work; therefore, knowledge is somewhat limited.

b. Lack of books or journals to provide guidance to those working in this field.

c. Due to the high cost of replacement parts and other budget constraints, product development progress is too slow. Moreover, spare parts have to be imported, sometimes causing production to stop.

d. Due to the need for and limited availability of changeable spare parts (i.e., head, screw, die, steam lock, etc.) for each experimental product, new product research is constrained.

e. Another obstacle to product development is the Wenger X-25 extruder's capacity. This machine is designed for a pilot plant operation, and each experiment consumed a great deal of raw materials. Often, moreover, the completed experiments were considered useless since they could not be implemented. And finally, a number of experimental products have met with failure at the marketplace. As a result of these factors such research has to stop.

f. Because the special raw material required--defatted soy flour--for making textured vegetable protein (TVP) in the form of a meat extender is still not available, the TVP product has not been developed at the institute.

BRADY EXTRUDER

Background

The IFRPD had been working on a high-protein, low-cost project in cooperation with the USAID from 1968 to 1977. When this project was almost terminated, the Brady crop cooker was introduced as a low-cost extrusion cooker by USAID and the U.S. Department of Agriculture (USDA). AID and USDA were actively supporting efforts to identify methods of producing nutritious foods at low cost in developing countries, and the IFRPD was a logical site to allocate one of the Brady testing machines since the IFRPD had already developed the extrusion cooking of indigenous cereals and legumes with the Wenger X-25.

A Memorandum of Understanding was signed by USDA and IFRPD which set forth the responsibility of the IFRPD of Kasetsart University to assess the usefulness of this kind of extrusion cooker for manufacturing foods in Thailand. If the results of the testing program were positive the institute would have the option to purchase this equipment and use it in Thailand to manufacture food products. Under the agreement, the Brady cooker was installed at the IFRPD in the beginning of 1978.

Testing Operation

On May 22 - June 4, 1978, Mr. Joe Kellerby, Colorado State University, provided Kasetsart University with technical assistance on testing the Brady cooker, with emphasis on start-up and training of personnel in proper operating and testing procedures.

The objectives of his visit were:

a. Determine product formulations for extrusion that were to be used by the IFRPD.

b. Operate the Brady for a break-in period.

c. Train institute personnel.

d. Discuss plans for the intended use of the Brady.

e. Conduct a demonstration program for interested groups.

Kaset baby food was used as a basis to design various formulas to be extruded through the Brady. As the Wenger X-25 had been used to manufacture the baby food, the IFRPD installed the Brady so that direct substitution of the present line could be made. However, some modifications were necessary to make the system compatible with the Brady:

a. A hammer mill instead of the Alpine was used to provide a larger granulation into the Brady.

b. Due to the browning effect, the preblending of sugar with the raw material had to be omitted.

c. The formula had to be adjusted to accommodate the absence of sugar and the eventual blending that would be done on the finished product.

The Brady was run on a rice-soybean mixture to polish the extruder's internal surfaces, followed by tests using mixtures of:

a. 85% rice / 15% dehulled soy.

b. 72% rice / 13% dehulled soy / 15% sugar.

Runs made with sugar as an ingredient were considered unsuccessful due to the browning that occurred and the inability to raise the temperature to a desirable processing condition.

Inadequacies of the present system are:

1. Batch mixing of raw materials.

2. Use of gravity flow for raw materials.

3. Additional mills are needed for raw materials and/or finished product.

4. Additional training for equipment operators.

Besides the above-mentioned items, the complete plant design needs some additional equipment. A request for funds for the completed plant design has been made to both the government of Thailand and to foreign governments in order to establish plants in various Regional Nutrition Centers in Thailand. At the moment, the project calls for 9 centers to produce baby food to solve the malnutrition problem in Thailand.

Brady Crop Cooker and Product Development at IFRPD

a. Protein-enriched Cereal Foods

After completion of the testing program with technical assistance from CSU, experiments were run on the Brady. It was decided to purchase the machine by the end of 1978. Local agricultural materials were utilized such as rice, cassava, soy, sesame, etc., to make the same products.

Since the IFRPD's baby food formula could be produced from the Brady, other similar products needed to be investigated. Mixtures of ingredients processed and their proximate analyses are shown in Tables VII and VIII.

The particle size of all raw materials for these Brady operations had to be of fairly large granulation; otherwise, the finished products were unevenly distributed. A little water added to the mixtures while they were being processed produced perfect gelatinized cereal products. The strong odor of fish meal was reduced after processing the meal through the Brady. The completed formulas are undergoing consumer acceptance testing.

b. Stabilization of Rice Bran

Rice bran is a by-product from rice milling. The bran constitutes about 8 percent by weight of the whole rice grains. The expectation of rice production in 1979 will be about 20 million tons, and the quantity of rice bran produced during rice milling will be 1.5 million tons per year--a significant amount.

Rice bran contains about 15.8 percent of fat and 13.3 percent of protein and vitamins.

Besides its high nutritional value for livestock, it is also a valuable raw material for production of edible oil.

Unfortunately, rice bran rapidly becomes rancid as a result of the hydrolysis of the oil into glycerol and free fatty acids by hydrolytic enzyme in rice bran. The stabilization of rice bran by heating can inhibit the hydrolytic activity of the enzymes to some extent. The heat can reduce moisture and the enzyme is denatured.

The Brady has attempted by extrusion to stablize rice bran at various temperatures. Free fatty acids (FFA) of processed rice bran were determined under various storage times as shown in Table IX.

Table VII. Formulation of Mixed Ingredients Passed Through the Brady

Samples	Ingredients	Formula (%)	Texture
1	Rice : Soy : Fish	75 : 20 : 5	well-cooked, crisp
2	Rice : Soy : Sesame	65 : 25 : 10	well-cooked, crisp, dark in color
3	Rice : Peanut : Fish	75 : 15 : 10	well-cooked, crisp
4	Corn : Peanut : Fish	75 : 15 : 10	well-cooked, crisp
5	Cassava : Peanut : Fish	55 : 30 : 15	well-cooked, sticky

Table VIII. Proximate Analyses of the Processed Mixed Ingredients

Samples [1/]	Moisture	Protein	Fat	Carbohydrate	Energy
1	9.26	16.3	4.32	66.4	373
2	8.55	15.3	11.35	61.4	344
3	10.04	16.7	7.46	63.0	410
4	11.39	18.4	10.09	57.0	379
5	8.58	23.2	14.55	49.6	409

[1/] Sample numbers are the same as in Table I.

Table IX. Free Fatty Acids of Processed Rice Bran from the Brady at Various Storage Times

Time (days)	Processed Temperature			
	Room temp.	170°F	200°F	230°F
	% FFA	% FFA	% FFA	% FFA
3	6.69	6.25	5.58	4.29
15	13.23	6.64	5.62	4.65
22	15.03	6.66	5.65	4.67
29	16.98	6.32	5.43	4.43
35	18.25	6.35	5.69	4.36
42	18.46	6.32	5.63	4.31

The results show that stabilization of rice bran by use of the Brady is possible and economical at a temperature of about 230°F. From the experiment, it appears that the stabilization of rice bran by the Brady offers a good future potential for a rice bran oil factory.

Conclusion

Preliminary tests of the Brady crop cooker indicated that this machine can be used to manufacture extrusion-cooked foods including full-fat soy flour and soy-cereal products. Extrusion-cooked grain products appear to have potential as low-cost, nutritionally-improved foods for use in Thailand. It has been proposed that infant and weaning food plants be located in rural areas where the nutritional problems in this country are found. Other products under investigation utilizing the Brady are high-protein, low-cost foods to serve other age groups.

According to the institute's work, results on the Brady indicate it can stabilize rice bran and that its potential in rice milling needs to be studied as to the economical utilization of rice bran for edible oil.

Country Report—U.S.A.

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Country reports have been given by most countries who have been associated with the LEC. It is the objective of this report to discuss items that have been investigated in the United States by the LEC project at CSU since the first workshop.

RECOMMENDATIONS OF 1976 WORKSHOP

Near the completion of the first LEC workshop the participants divided into four working groups to discuss different aspects of the LEC project. The four groups were:

1. Additional potential food applications.
2. Product evaluation--nutritional and physical properties.
3. Research to improve manufacturing operations.
4. Programming assistance.

All four groups compiled specific recommendations for the LEC workshop which are listed below.

1. Establishment of CSU as a clearing house for information gathering and dissemination.
2. Guidelines were to be established for the identification of factors needed for project success and assessment. A systematic format was recommended for collection and dissemination of the information.
3. A general operations manual was required for LEC systems. Such items as plant management, machine operations and quality control would be included in the manual.
4. Items recommended for specific equipment improvement included:
    a. Changing the extrusion outlet box, transition zone, screw wear, and extruder control was recommended for the Brady.
    b. Dissemination of information on cleaning and destoning equipment, dehulling equipment, grinding equipment, and proportioner and reduction mills was suggested.
    c. Spare parts lists for plants, guidelines for rebuilding spares, and painting of equipment were also discussed.

The above recommendations were used to establish priorities for the project. Several investigations have been undertaken in response to these recommendations:

INFORMATION GATHERING

1. A more complete equipment file containing manufacturers' literature on equipment that would be suitable in LEC systems.
2. A general file of information from countries or groups.
3. Publication of a newsletter twice a year. The "LEC Newsletter" is published in January and July. Prior to each publication information is requested from all people working with LEC's. This information is compiled and summarized in the newsletter.
4. Generation of a large amount of material pertaining to modifications, guidelines, etc., for LEC users. CSU has published a considerable amount of information which discusses various aspects of the project. Reports that are available include:
    a. Quarterly reports of CSU activities.

   b. Trip reports, many containing designs, plans, equipment lists, spare parts requirements, etc.

   c. Special reports, which treat subjects such as spare part repairs or rebuilding, evaluations of selected equipment, and other specific topics.

PROJECT ASSESSMENT

There is a real need for operating information from plants to gain insights on what might be expected from a LEC plant. Information pertaining to costs, maintenance, production, and product characteristics is required to determine if they are meeting project objectives.

Thus CSU and USDA have proposed a protocol for evaluating existing LEC plants and/or obtaining LEC system information. It is discussed in detail in another section of the proceedings.

GENERAL OPERATIONS MANUAL

A general operations manual was recommended by the participants of the first workshop to provide an aid to the individual plant. A manual has been prepared on plant operations. All phases of a plant's operation are discussed. The manual is divided into two parts:

1. Part I--Management and Operations.
2. Part II--Equipment Operation.

Included in Part I are sections on:

1. Management operations--job responsibilities, accounting functions, reports.
2. Pre-start-up installation and organizational procedures.
3. Training manual--used for training plant managers and operators.
4. Plant operations--overall view of the plant.
5. Proposed quality control procedures.

Part II addresses the specific pieces of equipment within a LEC plant, their function, and operation. This section of the manual discusses the following:

1. Conveying equipment.
2. Storage equipment.
3. Pre-processing equipment--dehulling.
4. Processing equipment--proportioner mill, LEC, etc.
5. Post-processing equipment--cooler, blender.
6. Miscellaneous--lubrication specifications, bolts, V-belts, chains, fumigation, pest control.

The manual was designed to be a general document for LEC plants. However, the manual can be made plant-specific by the addition of manufacturers' manuals.

MODIFICATIONS

Modicications to the low-cost extrusion cooker were discussed during the panel discussion. Work has been consistently pursued on modifying the LEC's and the systems to improve them. Changes which have been made to the LEC systems include:

1. Upgrading conveying equipment.
2. Addition of blending equipment.
3. Addition of an impact dehulling system.
4. Addition of cleaning and destoning equipment.

Changes to the Brady extruder have been:

1. Elimination of the hydraulic system--replaced with vibratory feeder.
2. Use of electric motors instead of diesel-drive motors.
3. Modification of the bearing weldment to permit more complete lubrication.
4. Initiation of rotor and cone repair procedures.

RELATED ACTIVITIES TO LEC SYSTEMS AND PRODUCTS

Other activities related to LEC's, systems, etc., have been conducted at CSU. These items did not fit into any specific category but should be mentioned.

Brady Screw Configuration

A study[1/] was undertaken to determine the effects that beater bars (screw channel restrictions) have on the operational characteristics of the Brady extruder. The study investigated

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[1/] Sahagun, Jaime. 1977. Parameters Affecting the Performance of a Low-cost Extrusion Cooker. M.S. Thesis. Dept. of Agricultural and Chemical Engineering, Colorado State Univ., Fort Collins. p. 165.

the location and number of beater bars on the rotor. Five different configurations were examined.

Temperature profiles were measured along the length of the barrel as a means of determining the effects of beater bar configuration changes. Temperature profile, specific energies and other considerations were discussed in more detail in the 1978 Annual Report.[2] Results indicated that the number of beater bars along the rotor length was not as critical as their replacement. Temperature distribution along the barrel could be controlled if beater bars were accurately placed on the rotor.

Dehulling Study

A survey of manufacturers was conducted on the best method to dehull soybeans and grain. Responses obtained usually suggested very large systems that were complicated to operate and too expensive. When seeking further information, a system called a scourer-aspirator was found commercially available and was considered as an inexpensive, versatile alternative.

The scourer-aspirator was discussed in detail in the 1978 Annual Report.[2] Tests with the scourer-aspirator system indicated that the fiber levels of soybeans and grains can be reduced sufficiently to meet or exceed PL 480 specifications.

Mechanical Evaluation

Colorado State University conducted a mechanical evaluation of the Brady crop cooker to determine its durability and reliability. The components of the Brady were also investigated to determine what major or minor modifications would be required to make the unit more durable.

Conclusions drawn from the evaluation are given below. To make the machine more durable, the following items would have to be done:

1. A metallurgical treatment of the wearable surfaces would be made to increase their hardness and wear resistance.
2. Eliminate or change the hydraulic system components.
3. Provide a design that would incorporate the use of an automatic lubrication system for the rotor bearings and universal joint.
4. Interchange drive train components to reduce the high torques transmitted by the universal joint.

Some of the above modifications have been implemented. In most instances, the change has improved the Brady's operation. Long-term data are not yet available.

Manufacturers' Survey

A survey of United States manufacturers and equipment users was conducted to obtain specific information on the durability of processing equipment. Each manufacturer or user was asked to comment on equipment with respect to: 1) normal life expectancy, 2) time between major overhauls, 3) cost of major overhaul (% of capital costs), and 4) annual maintenance cost (% of capital costs).

Responses were compiled and averaged to have data available for comparison with LEC systems.[2] Results indicated that except for the screw conveyors and extruder, LEC data compare favorably with the averaged survey data.

Brady Cutter

A special adjustable cutter was designed for use on the Brady to make shaped snack foods. The cutter consisted of a special spindle which was attached to the rotor. Bearings were placed between the spindle shaft and the housing that enclosed the spindle. The housing had cutters attached on the end closer to the die, and the other end was connected to a variable-speed reversible motor.

Tests were run on CSB at high temperatures to determine the most difficult chip to cut. Cuts made by the new cutter were screened to learn the size ranges which existed. Results indicated that the particle size did not change significantly, and the random appearance of the chips presented with the less sophisticated system using knives attached to the rotor still existed.

Roaster Tests

Alternate processes have been examined as a means of producing nutritious foods. One such process that meets specifications for low-cost processing is roasting. Several roasters are available in the United States; some use direct heat-bean contact, while others use a heat transfer media to heat-treat materials (particle-to-particle).

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[2] Harper, J.M., D.A. Cummings, J.D. Kellerby, R.E. Tribelhorn, G.R. Jansen, and J.A. Maga. 1978. Evaluation of Low-cost Extrusion Cookers for Use in LDC's. LEC Report 4. Depts. of Agricultural and Chemical Engineering and Food Science and Nutrition, Colorado State University, Fort Collins. p. 201.

CSU investigated the latter-type roaster, in which sand or salt was heated, and the raw whole grains were placed in the bed and allowed to mix in a chamber. The heat was transferred to the raw grain, which was followed by a screen separation of the particles. Roasted grain exited from the chamber while the sand or salt was recirculated. A diagram of this type of roaster is shown in Figure 1.

One of the major reasons for interest in the roaster is that it is an alternate manufacturing system for full-fat soy flour (FFSF). FFSF has been manufactured using LEC's; however, the oil coats the surface of the extruder product, making it cohesive and very difficult to grind. Specifications for manufacturing FFSF indicate that 99% of the final material must pass a 100-mesh sieve. The only practical way to grind extruder soybeans to 100 mesh is to use a pin mill. Pin mills are very expensive, and as yet little information is available to document their performance.

After processing, roasted soybeans do not have free surface oils since the bean is not sheared during processing. Thus the method of grinding can be changed to a less expensive and simpler grinder. Tests on roasted soybeans have indicated that a normal hammer mill can grind the roaster bean to 80 mesh with normal energy inputs. Data on trials indicated that the hammer mill could nearly meet the specification for grinding 100 mesh, although more power and/or a wider-chambered mill would be required.

A summary of operational, nutritional, and functional data is given in the 1978 Annual Report. 2/ A comparison of extrusion vs. roaster products is shown in Table I. In all instances, data indicate that the roaster is a viable alternative for manufacturing FFSF.

TECHNICAL ASSISTANCE

Colorado State University has provided technical assistance to countries at various levels. Generally, two levels of input have been provided:

1. Assistance to test sites.
2. Assistance to plant demonstration sites.

Assistance to test sites has been associated with training groups to operate a LEC properly. Additional assistance is usually available for helping to prepare or outline test programs with the LEC. The desired result from this program is to realize a complete plant for producing nutritious foods.

Assistance to plant demonstration sites has been in greater depth and of greater scope. Assistance that is available to plant demonstration sites includes:

1. Project planning--feasibility studies
2. Plant design
3. Equipment specifications
4. Equipment selection
5. Equipment purchasing
6. Installation assistance
7. Shakedown and start-up assistance
8. Training
9. Plant operation and logistical assistance
10. Follow-up backstopping assistance.

From time to time Colorado State University and USDA, with funds from AID/W, have provided special assistance in the areas of:

1. Production formulation
2. Marketing
3. Plant evaluation
4. Plant contractual assistance.

All of these areas have been a part of the total LEC program to date. In most instances, the demonstration plants have received the above assistance as part of the mutually-agreed-to Memorandum of Understanding between USDA and the host country counterpart.

One area of assistance which has changed since the project was initiated has been the training session. Training for demonstration programs now is more comprehensive and requires one-to-two-weeks of training for satisfactory results. Classroom, as well as in-plant training is given. In the future, manuals specifically designed for a plant will be provided as part of this training.

Currently, CSU is providing technical assistance to three demonstration countries: Sri Lanka, Tanzania and Costa Rica. It is our intention to continue to provide assistance to each of these plants until our current commitments are completed. The criteria for determining if our commitments are completed are as follows:

1. The demonstration plant is operational.

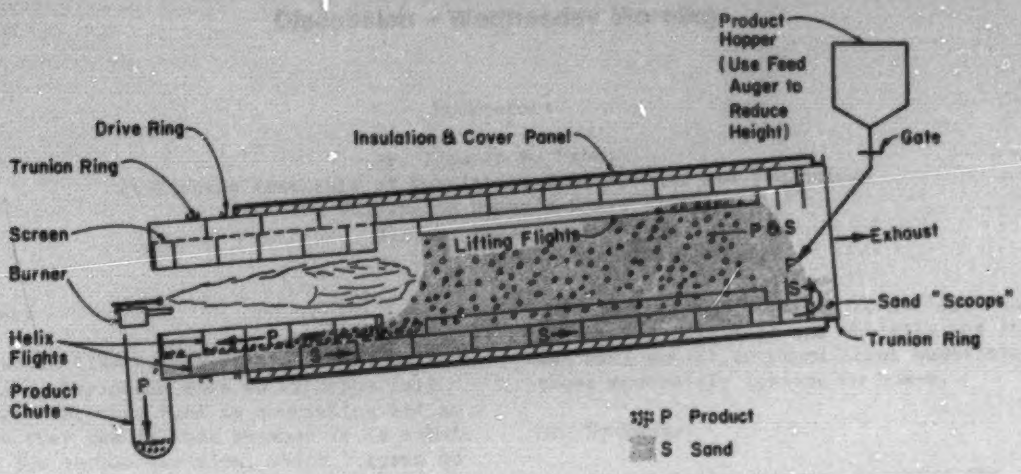
Product Hopper (Use Feed Auger to Reduce Height)
Gate
Drive Ring
Insulation & Cover Panel
Trunion Ring
Screen
Lifting Flights
P & S
Exhaust
Burner
Sand "Scoops"
Helix Flights
Trunion Ring
Product Chute
P
S
P Product
S Sand

Figure 1. Diagram of roaster using sand as a heat transfer medium.

2. The plant has demonstrated it can function by itself at at least 70% efficiency.
3. At least one year of data documenting plant operations has been obtained.
4. The Memorandum of Understanding has been fulfilled.

Completion of the above items will end CSU's direct involvement. Further types of involvement through a technology transfer center located at CSU is envisioned as an appropriate alternative to the existing programs.

Table I. Comparison of Extruded and Toasted Full-Fat Soybean Products

Test Parameter	Brady	Insta-Pro	Roaster
1. Average throughput (kg/hr)	456	245	865
2. Range of cooking (°C)	143-153	143-153	120-130
3. Power (kW)	36.94	15.93	113.96
4. Specific energy (kWh/kg)	0.081	.065	0.131
5. Range of % Trypsin inhibitor destroyed	55-80	55-80	75-90
6. Urease activity	0.23	0.09	NT
7. Final moisture, %	3.00	5.5	6.2
8. % Water absorption	369	252	234
9. NSI	37.30	13.05	21.93
10. PER	2.15	2.25	2.25

Discussion - Wednesday Morning

Moderator:

Dr. Ignacio S. Pablo
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The Philippine Women's University
Manila, Philippines

Mr. Lukoo:

I would like to ask whether the low-income group using Thriposha does so with the full knowledge that this food is nourishing and so on, or do they use it just because it is subsidized? The second question, which I guess we discussed this morning from a marketing aspect, is what will happen if the subsidy is removed? Will the people go on using Thriposha?

Dr. Nichols:

Distribution of Thriposha so far has all been either on a subsidized basis or free. The product has not yet been sold in a test market situation, so any responses we've got are from people who have been made aware of it as a result of a free distribution program through the MCH centers. They were receiving it because they were identified as being medically-identified recipients having some nutritional need. As to the second question, that is exactly what we hope the market test will tell us. Yes, we have reason to believe that there will be a sufficient number of the people, at least those with some income, willing to purchase the product. But we are not proposing this as a substitute for the existing program--it's going to be in addition to the existing program, so that those who have been receiving it or who continue to qualify because of having children in the right age group, or because they are pregnant or lactating women, will continue to receive it through the free distribution program. The commercial program is designed to reach into households which are not now eligible because they do not have children who meet the medically-identified criteria. It also will make it a lot more available in the community on a day-to-day basis so that those households can buy additional quantities if they want to because it will be in the retail stores. The MCH center distribution system reaches into the household maybe only once every two weeks at best, and sometimes, if the housewife does not show up or she does not bring her children, she may miss a month or two. But everybody goes to the local community store one or twice a week for something, and if you've got it there, we're hoping they will buy some additional quantities. We're expecting to get some response to the question from the market test phase that we're getting ready to enter as to not only how much of this we will sell and who will buy it, but who will get it in significant quantities in these moderately low-income homes.

Mr. Nyakunga:

In Sri Lanka they are stacking the bags in piles and from what was shown on the slides, it appears that they are stacking them very high. Isn't this dangerous? I am also interested in knowing what type of packing system they in Thailand feel best suits the basic low-cost system of production?

Mr. Goodyear:

To answer your question about storage and whether there is any damage, the availability of storage space is limited at our Thriposha packing location. The distribution channel goes from the packing center to another warehouse; at that time a 4% test-check is done on each of the master bags. They're looked at to see if there is any external damage and also opened to see if the packets are in good condition and then resealed. Certainly, packing 12-high is a factor of availability of space. We do have a final check before the eventual distribution is done--largely by rail--where the stacking is sometimes higher than 10-high and less than ideal. But this is one of the factors that we have to live with.

Dr. Pablo:

Professor Amara, did you get the question on packaging material?

Prof. Amara:

The polyethlene and Kraft paper is all right for local transportation. The problem in Thailand is that we export to our neighboring country, and the amount of handling at the harbor makes it necessary to use a polypropylene for that.

Mr. Nyakunga:

Don't you think you should ship it in metal containers?

Prof. Amara:

The containers are loaded at the harbor because they do not go to the factory. The system is different.

Dr. Pablo:

In the Philippines they go directly to the factory and are loaded there.

Prof. Amara:

That doubles your transportation costs, and with the oil crisis as it is, we have to containerize at the harbor.

Mr. Nyakunga:

Is there a certain temperature at which the food should be packed?

Ing. Clark:

You should be able to pack that product at 100°F with no problem.

Mr. Nyakunga:

The reason I raised the question is that I wondered whether, if the temperature is too high, as the product cools to normal, it may generate some moisture under the bag which could get into the food.

Ing. Clark:

No, it won't do that.

Mr. Lukoo:

I would like to ask how our relatively high maintenance costs can be explained?

Dr. Harper:

There has been some concern--rightfully so--at the conference concerning the maintenance cost figures that were reported here in Tanzania. We, too, have been concerned about that, and we recognize that apparently the maintenance is higher here than we have experienced elsewhere. We had an extensive meeting with the people at NMC last night with the idea of looking specifically into the causes of those and developing a plan to reduce them. There was, I think, substantial progress made along these lines. We are also reviewing the figures that were presented and are having some difficulty reconciling the numbers with some other calculations and experiences we have. Right now there are people at NMC going over the numbers again to make sure we are all talking about the same thing. I think it is a problem of definition, and hopefully we will have some additional things to report tomorrow. The point is, though, that it does appear that Tanzania has higher maintenance costs than some other plants have had, and we are exploring possible causes and solutions. We think the numbers that will eventually occur here--once the equipment is shaken down and the processing procedure is worked out--will be the maintenance costs we have projected.

Mr. Mosha:

Looking through the country reports quickly, one gets the impression that most of the equipment being used is either a loan or a gift from some organization like USDA or from manufacturers. Shall we continue to get these loans and donations? Surely, someday someone is going to say no, this is the end of it, and the money to continue is going to have to come from somewhere else. It is high time we think of what we are going to do when that happens.

An awareness of this technology has been created among technologists but I don't think my government is all that much aware, and they are the ones who will have the decision to buy the equipment. So we still have a job to do, even though we as technicians have been convinced.

Another thing that comes to mind is the fact that most of the products we are turning out are products that are going to welfare programs, and that depends on the type of government one has. If you're used to dealing with a government that espouses welfare programs, you're in business; if that government changes and is replaced by some other group that has different thoughts, you're just out of business straight away. So you need to be cautious and to prepare alternatives.

A few countries have tried to go into snack and other products, and to break into the commercial market with them. The products have to compete directly with other, well-established products already on the market, and despite some encouraging results in Sri Lanka, those of you who are familiar with most efforts to market high-protein foods know that it has proved to be an extremely difficult task. We should try to learn from history while still in our youth that these kinds of products have had a fairly sad story, and what the LEC system is trying to do, of course, is to turn the picture around by lowering the cost--though I still haven't been completely convinced that it is really low-cost enough.

Prof. Amara:

Mr. Mosha's concern about continuing availability of equipment is an aspect of technology transfer that concerns us all. This subject is being discussed by many developing countries, and the capability to make our own equipment in our own country is being seen as the best way to avoid that problem in the future.

As for his second point, that of changing of the government, that is why we have the National Planning Commission to set up a national policy for combatting malnutrition. The program should be a part of the national policy promulgated by the government for long-term development of human resources. It should be a complete program involving and acceptable to all sectors so that whatever the government change, it will have to be carried on. Of course, continuity can't be guaranteed in cases where dictatorships come into being and change everything, nor where other disruptive political factors are involved.

As for competition, we are not going to compete with the products already on the market because we are aiming for the poor people who can't afford the imported foods. In developing countries you will see quite a few snacks available in the market, most of them of little nutritional benefit, and the government has to bring to bear some influence on it from a consumer protection point of view. That will also come into the national policy, but the government usually will not do very much on this one. We who know the facts must teach the people, advise them and tell them what is good and what is not good, as we are doing.

Finally, Mr. Mosha questioned whether it is really a low-cost system. In our opinion, it is--certainly the soybeans are a relatively cheap source of protein--particularly if the government is committed to helping the poor and does not leave this area totally to the businessman whose motive is only profit. If the government monitors the profit margin, the cost will be low compared to the income of the people.

Management Considerations in LEC Enterprises

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My native country, the United States of America, has a reputation for efficiency brought about by its management competence in its manufacturing business. It has earned that reputation by reason of the competitive nature of our business climate. Only the successful survive. It is a poorly-kept secret that of all the new businesses started in the United States, about 1/3 are discontinued within the first year; 1/2 by the end of the second year; and 2/3 by the end of the fifth year. After the fifth year the failure rate drops rapidly. The reputation for success, therefore, is not based on the results of all of the businesses started, but instead is based on only the surviving 1/3. I must hasten to add that the right to fail in business in the United States is as precious as the right to succeed. It is a desirable weeding-out process wherein the people decide with their purchases who are providing the products and services for which they are willing to pay.

Dunn and Bradstreet, a large business credit reporting service which follows such matters closely, states that poor management--lack of management competence--accounts for 90% of the failures. If so, and it is probably true, purely technical competence deficiencies have to rate very low in the causes of business failures along with a myriad of other causes contained in the remaining 10%.

I have related these statistics because I believe that we actually are here discussing a small business enterprise that happens to be low-cost extrusion cooking of foostuffs. We are discussing the technology at length because the technology must be sound before an enterprise can succeed. A successful small enterprise is needed, whether it be in the public or private sector, in order to attain our goal of production and distribution of low-cost nutritious footstuffs from indigenous materials.

Good management may be simplistically defined as:

A. Knowing what needs to be done; and

B. Getting it done properly in a timely manner.

It should perhaps be added that the MAN in management did not come to be there solely by accident. Good management usually attains a large part of its result by working with and through other people--superiors, peers, and those lower on the ladder.

Because the risk of failure, or at least poor performance, is far greater from lack of management competence than it is from lack of pure technical competence, I shall now discuss the apparent requirements for management of a LEC enterprise.

All LEC installations with which I am familiar, actually installed or proposed, qualify as small business enterprises by any rational definition of the term. All that follows is intended to primarily define the management of such a small enterprise. Because the organizational structures will vary between plants, I shall discuss the matters on a functional basis. Someone needs to take care of the matters, but it need not be done by exactly the same organization people for every installation.

Operations Planning

Finished product requirements should be calculated, by product, as far into the future as firm requirements can be determined. A schedule should be prepared which will inform all concerned with the operating plan. That plan should take into account inventories of finished product and the replacement of inventories, if a stock is required. The firm operating plan should be based on firm orders for delivery, and the plant copy may be accompanied by the actual dated shipping directions.

From the operating plan, raw material and package material requirements should be calculated, taking existing inventories into account. Orders and deliveries of these materials must be timed to assure continuity of plant operation in keeping with the plan. In other words, the lead time for deliveries has to be taken into account. Where lead times are long--for example, imports from overseas or a domestic crop that will disappear from the market--an inventory may be required and maintained based upon budgeted needs. A schedule of expected material deliveries should be provided to the plant.

Manufacturing

There are two major areas of required control in manufacturing, and they are inter-related:

A. Process control has three major elements:

1. Recovery from raw materials - yield of finished products from raw materials.
2. Maintenance of production rates.
3. Maintenance of finished product quality.

B. Expense control has two major elements:

1. Labor - having the right number of people available to do the work; no more, no less.
2. Materials and services - control of the use of operating supplies, minimizing maintenance needs by attentive operators, conservation in the use of electric power and fuel.

The largest cost element by far in most LEC finished products will be raw materials; therefore, control of yields is perhaps the most important task of the manufacturing people. Losses will occur in cleaning grain, decorticating grain, moisture losses in cooking, and there usually will be a small unexplained loss that should not exceed about 1%. Shift operators should routinely monitor their equipment to insure that it is adjusted properly.

They should also routinely examine the separates from the cleaning and dehulling machinery to insure that materials suitable for product manufacture are not passing into the offal. Each shift of operation, the percentage yields of finished product from raw materials should be calculated. Low percentage results should demand immediate correction.

Maintenance of the material feed rates at machine capacities is obviously essential to low-cost production. Machine operators tending the ingredient-feeding devices should routinely check them for proper functioning, and there should be an hourly check on the packer tally at the end of the system. It is important from both the financial and nutritional viewpoints to insure that the proper proportions of materials are being fed to the system. Soybeans cost more than cereals. The total rate of feed may be all right, but the proportions erroneous--which may increase costs, destroy the product's nutritional balance, or both. Check and monitor the feeders regularly during each shift for proportioning integrity. At least monthly, prepare a materials' variance report which will show actual usage of materials versus standard, and the result in money terms.

Quality control will be discussed in more detail under the heading; however, it is obvious that proper quality originates and is maintained by proper process control if the correct ingredients are fed into the system. Assuredly, the most effective quality control will result from attention to processing detail at each step from raw material feed-in to the finished product packer. The management simply cannot be satisfied with shift supervisors and machine tenders who merely provide assurance that the machinery is running and product is passing through it.

It is not unusual to find that employed labor is provided to meet any emergency. Good practice provides only the labor required to do the job properly under normal conditions. Emergency needs are provided by overtime work, or if necessary, the employment of temporary people. Emergencies are few and far-between in a well-managed plant. The frequency and severity of emergencies are, in fact, a good index of the efficiency of management.

The prime control on usage of operating supplies, maintenance materials, power and fuel must be exercised by shift supervision and the operating labor. Management will judge the efficiency of that control by its own supervisory observations and its evaluation of the expense reports discussed later in this paper.

Maintenance

While maintenance of a plant is actually a part of the production function, it is of such importance in most developing countries that it is emphasized here.

Good maintenance begins with well-trained production supervisors and machine operators. They operate the equipment properly as it is designed to be operated. They observe and correct minor abnormalities before they become serious, such as tightening screws and bolts. They use the simple tools required for such minor maintenance properly, so that damage is not incurred by the very act of correcting a defect. They service the equipment--lubricate and adjust it properly. They shut equipment down promptly when abnormalities develop that either must be corrected before production can continue or when continued operation will escalate damage.

Parts inventory maintenance is critical in most developing countries by reason of the lead time required for resupply.

Usually the best way to solve this problem is to:

A. Have a neat, clean storage area with a place for all required parts and all of such parts in that place.

B. Maintain a book inventory of parts, kept currently posted, which reflects usage; reorder point, taking lead time into account; orders for resupply; follow-up point for orders on file; and receipts. In this book system treat repairable parts and assemblies of parts the same as you treat a part. Take a physical inventory at least once per month and reconcile the books to that count.

C. Dispose of non-repairable damaged parts when removed from equipment. Immediately repair parts suitable for repair and return them to inventory.

Maintenance people must be well-trained in the requirements of the specific machines involved. Auto and farm machinery mechanics, available almost everywhere, are the most likely pool of candidates for selection for specialized training for LEC equipment.

Proper tools in good condition and stored in a clean, neat manner are requisites. People doing maintenance work must use proper tools; otherwise, they needlessly damage machine elements. People should not do maintenance work requiring skill levels beyond their training and sensitivity to the needs of the equipment. Additional damage will be done by the use of improper repair techniques.

Quality Control

As stated before, "real time" quality control is exercised by production operators, if their raw materials are suitable for the end results expected. Nevertheless, their success in accomplishing production of standard products must be monitored.

Most LEC's will be used to produce palatable, nutritious foods. There must be enough monitoring of quality to insure that the products do in fact routinely attain the standards for palatability and nutrition set by management for them.

The set standards should have a rational reason for being, and those reasons should be well-known to those who are making the product. They should be actionable standards--a proper reason for rejecting the product from distribution if the product does not meet the range parameters established. If at all possible, the factors should be capable of rapid, objective, accurate measurement. No one has as yet devised an objective, practical method of measuring the nuances of taste, odor, and appearance.

The test methods devised by CSU for "in-plant" testing of cooked cereal-soy mixtures and the raw materials are for the most part objective, rapid, and suitable. They can be performed by trained people with the equivalent of a high school education who can read, write, and perform simple arithmetic. College graduate-level food technologists or chemists should not be a requirement.

Organoleptic testing, to use a fancy term, is of great value in maintenance of food quality when performed by a well-trained person in whom you have confidence. Finished foods that look, taste, and smell like they are supposed to are seldom far out of tolerance.

Simple physical testing for foreign matter, moisture, granulation, gelatinization, and perhaps density; plus taste, odor, and appearance evaluations on raw materials and finished products should prove to be quite adequate to assure product quality when accomplished on a frequent schedule by well-trained, reliable people.

Periodically, perhaps once per month, a standard sample from production should be submitted to a dependable outside laboratory for testing to insure that the product continues to possess the nutritive values estimated for it.

Such testing may include some or all of the following: protein, ash, fiber, fat, calorie content, micro-organism plate counts, and micro-nutrient (vitamin and mineral) content. Such testing will usually only tend to provide a continuing record of the suitability of the product for the end use and values expected for it. It will usually be too infrequent and too slow in reported results to provide useful information for daily quality control. Certainly, out-of-standard results from such testing should provide cause for immediate review of formulae, raw material quality, and operating procedures to find and correct the deficiency. Retesting to verify the reported result should probably be the first order of business, because errors in such determinations are commonplace.

Colorado State University has prepared a quality control manual covering some LEC products. Whether or not that manual provides the exact detail needed for a product one wishes to manufacture, the format and general outline for quality control are excellent and could serve any management as a guide in developing its own quality control program.

Accounting

A standard simple system of financial accounting for small manufacturing businesses is needed for a LEC enterprise. Suitable systems can be purchased in book form, with replacement sheets available, all at nominal cost. A good bookkeeper can easily keep such books of account with nominal training.

Irrespective of the exact form of financial accounting system employed, it should as a minimum provide for:

A. Inventory accounting by item, and its value.

B. Sales and accounts receivable.

C. Accounts payable.

D. An expense chart of accounts with enough detail to permit analysis.

E. A monthly and annual operating statement closing so that management can closely follow the financial progress of the business.

F. An annual standard balance sheet which fully describes the current financial status of the business. There is some benefit to be gained by more frequent preparation of the balance sheet; however, annual preparation is minimal.

G. A proper balance sheet will, of course, require accounting for capital investments and depreciation.

A bit of specialized internal accounting is needed for a grain manufacturing business:

A. Costs per unit of product need to be calculated--both historically and for estimating future operations--for budgets and sales cost purposes.

B. The basic documents required to calculate costs per unit of product are product and by-products' yields, with enough time history to reasonably assure validity. The cost of raw materials delivered; the value of by-products; and expense per unit--with these data, costs loaded on board a delivery vehicle can be readily calculated.

While total costs and expenses by account will provide the required operating statements and balance sheets, modern management generally exerts its internal control by ratio analysis; i.e., percentage yields, percentage return on investment, costs per unit, expense per unit, percentage profit on sales, percentage gains or losses, etc. Ratio analysis of operations will prove to be useful to the manager of the small enterprise. It will improve his control, if he uses it.

Management

Next we come to the practically indispensable ingredient in the small enterprise--the manager. Such small enterprises can seldom, if ever, afford the highly-trained scientists, engineers and business experts that would be so useful for counsel. Instead, the manager himself must provide the major portion of the expertise needed for daily operations.

Certainly he will have the benefit of the counsel of his people, but he will have to evaluate that counsel and make the daily decisions. He need not be an innovative genious in order to do so, although that quality would help, but he must know what needs to be done and how to do it on a timely basis with the men, plant, and materials available to him if the enterprise is to succeed. He may escape the highly-skilled requirements of his job by hiring such talent on a short-term basis, but he cannot escape the demands of day-to-day operations for good decisions. In order to provide them he must know the details of every operation in the small business. He need not have the manual skills of every employee, but he must be able to judge the performance of those who are exercising manual skills--maintenance work, for example. This means that he must participate in all of the training for every job; it means that he must understand and embrace the goals of the program.

Manuals for Management and Training

Colorado State University is presently completing manuals covering training, operation, maintenance, quality control, and accounting for a LEC small enterprise. These manuals may not provide the specific detail for every LEC application that may be initiated by imaginative people; however, it is expected that those manuals will provide a format--an approach to-- any LEC application that can presently be foreseen. I recommend that each of you operators of LEC systems or you who are seriously contemplating such installations beg, borrow, or even steal copies of these manuals when they become available.

Marketing

Those private entrepreneurs among you may have noted at least one major omission in the prior discussion. Marketing skills--advertising, selling, and delivery traffic considerations have not been discussed. If the private entrepreneur is selling in the private markets, such skills are a requisite. Even the public sector enterprise may require some effort in these areas. These areas were not forgotten--they are just so specific to the particular goals of the enterprise that they need to be considered without fail for each specific goal. Areas that will require consideration:

A. Product design, including formulation.

B. Package design.

C. Acceptability testing vs. prime competition.

D. Estimation of market potential.

E. Estimation of profit potential.

F. Preparation and funding of an adequate advertising program.

G. Preparation and funding of an adequate sales and promotion program.

Discussion - Thursday Morning

Moderator:

Dr. Fernando Sanchez Arellano
Organization of American States
Washington, D.C. USA

Mr. Nyakunga:

I want to comment on the selection of a manager to run an extruder. I don't totally accept the statement that the person is not supposed to be a genius and to know everything that's going on in the plant. In most of the developing countries we have had the same assumption that this job can be done by anybody. This has been wrong and has led to a lot of deterioration of values and jobs. It is my view that if you are assigning somebody to any job, you should assign somebody who has got the idea of the job--how it is run and how it is operated--so he will be able to control others who are assisting him in performing related jobs. If we take for instance our machinery here, and we appoint somebody who is not trained--who doesn't know even the system of sanitation, despite having the capability of being there as a manager--I feel we will run into a problem.

Mr. Ackels:

Perhaps I didn't make my point entirely clear. I believe I said that this manager is the indispensable man. And I meant just that. He must know the system. When I say he does not need to be a genius, I think that can be supported, also. But he must be a vigorous manager, he must know his system and he must know what is going on in his plant if he is to manage well. In most of these systems--I can't speak for all of them because it will depend on funds and countries available--one will find it very difficult if not almost impossible to have trained food technologists running laboratories. They won't be available because there aren't enough of them. This is why training in these specific areas of need is so important. One doesn't have to train people in every conceivable area of the grain/food processing business; one has to train them very carefully in the specific food/grain processing systems that they are going to be employing in that plant. This is what I was trying to convey, and I believe it will stand up.

Prof. Amara:

Related to the previous question, often in the developing country managers start out as bookkeepers and are always looking primarily at the balance sheet, lacking knowledge of the technology or the processing system. This sequence should be reversed.

Mr. Ackels:

Absolutely.

Prof. Amara:

Also, once you have the right man in the job--this part-artist, part-technician who runs the machine--how can you maintain his satisfaction with his job?

Mr. Ackels:

What we are talking about here is esprit de corps. In other words, you are asking how you make people feel they have the best job in the world in the best place in the world. That's another function of a manager, one of these people who are all things to all people within that organization. You do it with incentives such as pay and recognition. You point him out as being an outstanding operator in that field, and you make him feel that he is appreciated. This is esprit de corps--trying to get the people on your property to feel like they are very important people, doing an important job and doing it well, if they are in fact doing it well.

Dr. Chin:

I would like to underscore what Mr. Ackels said about a good manager's needing to know what has to be done and getting it done in a timely manner. I think this is most important because in a particular enterprise you must know what you want. You not only need to make a profit, but in a state enterprise you also have particular overriding national objectives you must balance, because you must maintain your profit position if you are going to stay in business. That is just as important in a state enterprise as in a private enterprise, because if the state enterprise doesn't stay in business it won't be able to make the food to feed the nutritionally disadvantaged it's trying to reach. I think we must go about this by identifying the so-called key areas in the particular business in relation to the objectives. This differs from one situation to another and from one country to another; therefore, while in some areas marketing may be very important, possibly in a particular country like ours, in which the market is a relatively closed one in terms of restrictions on imports, it might not be considered so important as the technology part, although it is still very important. One should systematize this process of identifying true objectives. In our case it is to insure that the food reaches the pre-school child who is malnourished; at the same time, we have superimposed on this the profit objective in order to maintain ourselves in business. One should really sit down and write them down at regular intervals, that is, monitor to what extent you have reached your objectives, and if you have not, how you go about changing your approaches in order to reach them.

Mr. Ackels:

I think that you are absolutely right. The understanding and reviewing of goals to be certain that they remain the same from year to year is important. I would like to add one thing to your comment on marketing. Some of the techniques of marketing are every bit as important to a state enterprise trying to distribute to a target population as they would be to a commercial venture. If you don't have the appealing flavor and palatability of product that people want, they won't eat the product. You won't maintain the distribution--even if you get it started--without that sort of acceptability, and those are marketing techniques that are simply emphasized even further in a commercial venture as opposed to a state venture.

Mr. Nyakunga:

I want to raise a question on quality contol. You said that it is possible to operate machinery with people who have a high school level of education and that a person who is operating the plant should have the knowledge and understanding of what quality of food he is producing. I feel that is not logical; the person who is the worker, that is, is entrusted to do the work only, doesn't have the interest in knowing what is coming out. He just waits for your instructions and does the job and does it well. Then you have another person who is really interested in the work and at the same time is developing an interest in the product. If you have both these people operating the extruder, you don't expect the quality to be controlled. Suppose you take the one who actually wants to work, puts all his energies into working, and switch him?

Mr. Ackels:

You are saying that you think you can't do it without the man's knowing why he's doing it. I suppose it is possible if you supervise him closely enough. This again involves esprit de corps, having people know enough about their jobs so that they are not only concerned with putting in a given number of hours and collecting a given amount of pay, but also with looking at the job with some pride of accomplishment, a job they want to do well--and that they know enough about so they will know when they have done it well. If we simply have a worker who puts in 8 hours working hard but without knowing what he is really there to do, in the event of any slight deviation in the chore--and if you're not there to tell him to deviate with it--he's going to just continue as he has before. You can supervise it that way if you wish, but you are not building organization when you do that. You are not building the capacity to grow. If that man is working alongside the Brady operator, the Brady operator knows what he's supposed to be doing and will want to make a Brady operator out of the other fellow. If you don't do so until he suddenly has to take over, you will have to start from the beginning again to train him. He could have been learning; he could have been a most useful replacement man, perhaps all the way along in his training and experience. These are the in-plant training opportunities that are available to you as you go along.

Evaluation Protocol of LEC Demonstration Projects

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INTRODUCTION

Low-cost extrusion cooker demonstration projects (LECDP) in Sri Lanka, Tanzania and Costa Rica have been a major part of the LEC program. Demonstration projects were designed to:

1. Provide a low-cost, low-technical-input food processing facility to produce a nutritious human food in less developed countries (LDC's).
2. Demonstrate the suitability of the LEC in a production-oriented situation.

To satisfy both of these objectives, AID/USDA/CSU, in connection with counterpart groups, have implemented food processing facilities in the countries listed above. As a part of this implementation, equipment selection, plant design and technical assistance for installation and start-up and in some cases equipment have been provided.

To determine if the above objectives have been fully achieved, there is a need to gather certain information from LECDP's. This information, along with the methods of collection, is the subject of this paper.

As a part of the understanding between AID/USDA/CSU and the group(s) obtaining technical and financial assistance for LEC plants in Sri Lanka, Costa Rica and Tanzania, both parties agreed to provide certain inputs and both expected a certain documentation of results. The primary result for the user group was a system that would manufacture low-cost nutritious foods; for AID/USDA the desired result was to gain information that would suitably demonstrate the use of the LEC system in production. All of the plants are now or soon will be in operation, so that it is a suitable time to discuss the specific evaluation protocol.

We have drafted a specific protocol to assure uniformity and thoroughness of information needed to demonstrate the use of LEC. The information will be collected over certain intervals, analyzed and summarized in an evaluation report. The report will provide a descriptive and quantitative summary for selected intervals of operation. I would like to describe the proposed protocol, so that workshop participants can suggest changes or make recommendations to improve it.

PROTOCOL OBJECTIVES

Objectives of the evaluation protocol of LECDP's are listed below.

1. To obtain data that will document the ability of LEC to produce low-cost nutritious foods and the suitability of the LEC system for production.
2. To develop a systematic means of collecting data that will provide answers to specific questions on operation, costs and product.

PROTOCOL DEVELOPMENT

To develop a protocol for obtaining evaluation data, a set of questions was proposed. These questions are general and would be answered by quantitative and/or descriptive information. The answers would also describe how specific LEC plants are performing.

General questions that we believe must be asked of each demonstration project are given below.

1. How much did the LEC system cost?
2. How reliable is the LEC system?
3. What is the expected output of the LEC system?
4. How many people are required to operate the LEC system?
5. How good is the quality of the product made using the LEC system?
6. What supporting services are required?
7. What are the requirements for imported equipment and materials?
8. What might be done to improve the LEC system?

PROTOCOL DEVELOPMENT DISCUSSION

The eight questions proposed above, along with specific details for each question which must be obtained to fully respond to the major question asked, are given in Appendices I through VIII. Applicable definitions and examples are given to explain the specific data required. Comments on each question are given below.

Question I. How much does the LEC system cost?

Two types of costs contribute to the total expense of the system: capital and operating.

Capital costs are one-time costs that must be amortized over the estimated life of the plant. Included are the costs for design and installation of the system plus the working capital or funds tied up in inventories of raw materials and finished product.

Operating costs are associated with operation of the plant. These costs change frequently due to the cost variability of the line items in Appendix I that contribute to the total cost. These costs could be summarized on an hourly basis.

Question II. How reliable is the LEC system?

To evaluate the reliability of the system, answers to the items in Appendix II will have to be made. Reliability of the system will be determined by the following items:

1. Production efficiency
2. Operating efficiency
3. Production per scheduled hour
4. Percentage of downtime
5. Percentage of product within specifications.

Production efficiency defines the plant's productivity during potential operating hours. This term omits the time lost due to late starts and logistical problems not directly related to the plant operation (e.g., lack of transportation, etc.) from potential operating hours.

Operating efficiency is an overall term that compares the operation of the plant (hours per day) to the number of scheduled hours for production. This term takes into account all losses of time, regardless of cause.

Downtime is expressed as a percentage of the scheduled operating time. The percentage listed for each specific cause defines the frequency of occurrence.

Percentage of product within specifications is a term which gives information on what proportion of the product meets the existing specifications. Amounts of off-grade, or out-of-specification, products could be determined. This comparison will give results relating to the ability of the plan to produce a satisfactory product.

Question III. What is the expected output of the LEC system?

Appendix III defines the specific items needed to answer this general question. The quantity that would specify the expected output is the actual recorded production. This quantity would represent actual conditions and is thus a good indicator for production within plants of similar design.

In addition to the output, data are necessary to quantify the energy requirements to operate the plant for a specific output. This information would answer how much energy is required for a given process.

Information on beneficiary levels is given to compare the output of the plant with the utilization of the product. This comparison would indicate the quantity of the stored finished product on hand and whether or not the system is capable of producing the amounts of product necessary to meet the beneficiary or other end-use demands.

Question IV. How many people are required to operate the LEC system?

The necessary numbers of managerial, operational and other personnel are essential to defining the operation of a LEC system. The questions in Appendix IV will provide specific information to quantify the labor force for a system. A list of various levels of plant operation, with the number of personnel per category, would be presented to answer this question.

Question V. How good is the quality of the product made using the LEC system?

To answer this question, the information obtained from the answered questions in Appendix V would have to be combined into a definitive statement followed by supportive narration. A judgment on what level of acceptance constitutes a good product would have to be determined.

To quantify the quality of the product,
ollowing score card would be used:

roduct Rating		Percent Acceptance
xcellent	-	95% or greater
ood	-	85-94
air	-	75-84
nacceptable	-	less than 75%.

The percentage of acceptance would be
verage of consumer and distributor accep-
surveys.

ion VI. What supportive services are
required?

Supportive services (such as those given
pendix VI) that are related to plant
llation and operation need to be identi-
Information resulting from this ques-
would be used to evaluate whether compa-
services would be available for a new
ity in other countries. Descriptive
mation on the types of service, how they
used, and amounts of service would be
d in response to this question.

ion VII. What are the requirements for
imported equipment and materials?

Historical information on the require-
to import equipment and materials and
hese requirements affected plant design
quipment selection is needed. Suggested
mation on this subject is given in Appen-
II. A detailed narration discussing
or all of the points would have to be
ded to answer the general question. The
mation would also provide a source of
for future reference.

ion VIII. What might be done to improve
the LEC system?

Appendix VIII offers questions which
give a perspective viewpoint on system
vement from various labor, management,
eer levels. The responses from each
oint would be compiled to determine im-
ments for both the system and product.

COL DATA

The amount of data collected to answer all
col questions would be significant. To
e the problems associated with data
ction, it is proposed that summary forms
ovided that would organize data suppor-
to answering the eight general questions
monthly basis. These data would then be
cted at convenient times throughout the
by LEC project personnel.

It is felt that the general questions represent a basis for evaluating the various aspects of the LEC demonstration system. Upon review of comments and suggestions by the workshop group, the protocol will further be developed. It will include a set of forms and instructions on how to use the forms to obtain the desired information.

APPENDIX I

LEC SYSTEM COSTS

I. How much does the LEC system cost? (Single-time costs that must be amortized over plant life by month.)

   A. What are capital costs?

      1. Cost of equipment used
      2. Cost of building or rental
      3. Other capital costs

   B. What are installation costs?

      1. Cost of materials
      2. Cost of labor
      3. Other related costs

   C. What are technical assistance costs?

      1. Engineering assistance costs
      2. Nutrition assistance costs
      3. Marketing assistance costs

II. How much does the operation of the system cost? (Variable costs of the plant on a monthly basis.)

   A. What are operating costs?

      1. Material costs - amount used per month and value.

         a. Raw material cost
         b. Offal sales
         c. Packaging material costs

      2. Labor costs - hours spent per plant area and value.

         a. Cleaning - foreign material removal
         b. Dehulling - preparation of raw material prior to processing
         c. Processing - processing of material to final formulation
         d. Packaging - final formulation containerization
         e. Other - miscellaneous

      3. Maintenance - daily and preventive costs--hours spent.

a. Cleaning - same as #2 above
b. Dehulling - same as #2 above
c. Processing - same as #2 above
d. Packaging - same as #2 above

4. Spare parts - parts and their costs required on an area basis.

    a. Cleaning - same as #2 above (specific list by equipment)
    b. Dehulling - same as #2 above (specific list by equipment)
    c. Processing - same as #2 above (specific list by equipment)
    d. Packaging - same as #2 above (specific list by equipment)

5. Managerial costs - cost of management on per-plant-area basis hours of management required and cost.

    a. Cleaning - same as #2 above (shift supervision)
    b. Dehulling - same as #2 above (shift supervision)
    c. Processing - same as #2 above (shift supervision)
    d. Packaging - same as #2 above (shift supervision)
    e. Plant management
    f. Other managerial costs

6. Utility costs - quantity used per month and value.

    a. Water
    b. Electricity
    c. Sewer
    d. Other

7. Lubricant and fuel costs - quantity used per month and value.

    a. Grease
    b. Oil
    c. Diesel
    d. Gas
    e. Other

8. Other related costs.

B. Product distribution costs - per-month basis.

1. Transportation costs (quantity product distributed and cost to transport). (Length or distance of transport)
2. Labor costs (hours labor used for distribution and value).
3. Other costs.

APPENDIX II

LEC SYSTEM RELIABILITY

I. How reliable is the LEC system?

A. What is production efficiency?

1. Recorded production per hour divided by designed production per hour. Recorded production averaged monthly hourly production.

B. What is operating efficiency?

1. Monthly averaged hours in production per day divided by scheduled hours for production per day.

C. What is the production per scheduled hour? Recorded production divided by the scheduled hours for production.

D. What is the downtime? Number of hours down by specific event, as a percent of total scheduled operational time.

1. Equipment-related
2. Material-related
3. Labor-related
4. Power-related
5. Other.

E. What proportion of product is within specifications? Comparison of quality control standards with actual tests performed.

1. Total amounts raw materials used on a monthly-basis inventory record.
2. Calculated formulation percentages.

F. Likes/dislikes of managers/operators (descriptive information).

1. Equipment-related
2. Plant area-related
3. Plant as a whole
4. Environment-related
5. Working conditions-related
6. Other.

APPENDIX III

LEC SYSTEM PRODUCTION

I. What is the expected output of the basic system?

A. What is scheduled production? Designed production of the plant per hour and per month basis.

1. Scheduled days of production
2. Scheduled shifts per day (length of shift)

B. What is actual production? (per-hour and per-month basis)

1. Actual days of production and quantity produced.
2. Actual length of shift (average length over month).

C. What are specific energy requirements for plant? (kW-hr/kg)

1. Recorded energy inputs (electricity, fuel).
2. Hourly production.

D. What is beneficiary or user level?

1. Number per month receiving food or quantity sold per month.
2. Ration-size-- amounts each user receives per month or size of packet sold.
3. Percent of identified malnourished group where material is distributed (survey identifying group).

APPENDIX IV

LEC SYSTEM PERSONNEL

I. How many people are required to operate a LEC system?

A. Number of supervisors, operators and other labor required? (per plant area)

1. Cleaning
2. Dehulling
3. Processing
4. Packaging
5. Sanitation
6. Supportive service (electrician, mechanic, etc.).

B. Amount of management required?

1. Quantity and level of management for total plant.
2. Quantity and level of management per plant area basis.
    - a. Cleaning
    - b. Dehulling
    - c. Processing
    - d. Packaging
    - e. Sanitation.

C. Where is more (less) labor required?

APPENDIX V

LEC SYSTEM PRODUCT QUALITY

I. How good is the quality of the product made using the LEC system?

A. How acceptable among recipients? (mother-child acceptance)

1. Likes -appearance, functionality, flavor, etc.
2. Dislikes - appearance, functionality, flavor, etc.
3. How is product used? (survey)

B. What is acceptability among distributors? (descriptive)

1. What are programming problems? (distribution, education)
2. Preparation problems? (feedback from recipients)
3. Infestation problems? (amount of material infested)
4. Shipping/storage losses? (comparison of plant dispatch with distributor receipts)
5. Packaging? (broken packages, improperly sealed, etc.)

C. What are some of the logistical information about the product?

1. How is product distributed (percent by mode of transportation)
2. Who receives product--target group?
3. How many receive product?
    - a. Prior to LEC system
    - b. Progression of expansion of beneficiaries since system initiation?

D. How might product be improved?

1. Size granulation
2. Functionally
3. Other?

APPENDIX VI

LEC SUPPORTIVE SERVICES

I. What supporting services are required? (list frequency of use and total hours of use per month per contract)

A. What services were required for installation?

1. Equipment placement (contractor, personnel).
2. Electrical (contractor, personnel).
3. Other (building modification or erection).

B. What services are required for plant operation?

1. Equipment repair (items repaired in-country such as rebuilding rotor, etc.).
2. Product promotion (advertising, art work, etc.).
3. Product evaluation (laboratory tests, proximate analysis, etc.)
4. Legal matters (contract development, etc.).
5. Building repairs (roof leak, light replacement, etc.).

APPENDIX VII

LEC SYSTEM IMPORT REQUIREMENTS

I. What are the requirements for imported equipment and materials?

A. How much equipment was imported? List of plant equipment and governmental requirements for importation.

B. How much equipment is produced locally? List of plant equipment.

C. What are foreign exchange requirements?

1. Who can obtain exchange?
2. Cost of exchange?

D. What equipment in existing plant could be replaced by local equipment? Costs associated with this change?

E. What was provided through donation or loan programs?

APPENDIX VIII

LEC SYSTEM IMPROVEMENT

I. What might be done to improve the LEC system?

A. What can be done to improve system? (descriptive information)

1. Operators' opinions.
2. Management opinion.
3. Other.

B. What can be done to improve product?

1. Consumer or recipient opinion.
2. Distributor opinion.
3 Other.

Discussion - Thursday Afternoon

Moderator:

Dr. Alfred Lachmann
USDA/OICD
Washington, D.C. USA

Mr. Nave:

I suggest that on management time you add another item for reporting. This takes up to 50% of our factory manager's time, and it is a part of the total production picture.

Dr. Chin:

One has to relate the cost to the benefit, and sometimes the amount of time you have to spend collecting a particular set of data might not be worthwhile. You need to devise forms and establish a system for data collection that takes a minimal length of time.

Mr. Tribelhorn:

I think the number and kind of forms that are generated will be specific to a particular plant. Some plants are going to have more items than others, particularly of a descriptive nature. A number of the plants so far have a donation-type program, and you can get quite a bit of information from the people in the field. On commercial-type applications, you are going to have to rely on feedback through other channels, so you will have to change the forms accordingly.

Mr. Cregger:

I wonder if you're not trying to draw too fine a line with your cost analysis. I think you are going to collect some pretty arbitrary cost breakdowns when you detail managerial costs. You have one manager and maybe one supervisor in these plants, and trying to record accurately how much time he spends between cleaning and hulling, processing and packaging, and a thing called plant management--I'm not quite sure how you would break that one down--it is very time-consuming. You're working with a small number of people under most circumstances, and if you're going to do it accurately, it's a lot of work. I'm not sure that it is that valuable for you to know that the manager spends 10 minutes a week managing the dehulling process, for example.

Dr. Harper:

I think you're right. In most instances you've got a very small group; in fact, all three demonstration plants where you are going to collect data are small operations. I'm not sure of the total structure yet in Sri Lanka, but there we've been discussing a plant manager plus shift supervisors. Now the shift supervisor will be a management-type person, and that's where that category would come in.

Mr. Cregger:

You are still dividing 4 people's time up in this process, and I think it's going to be an arbitrary judgment as to how much time is being spent where. I'm not sure you would know enough when you got through to make it worthwhile.

Dr. Harper:

This protocol answers a logical need to document the demonstration plants aready in existence so that others can have a clearer perspective of what low-cost extrusion cooker technology is all about and how it may be applicable to some of their specific problems. I think this is an important and necessary output of what we are doing, but we need to remember that these process systems represent first or not more than second efforts to demonstrate LEC technology. Consequently, I think it is important to put the analysis in the framework that the results may not necessarily be the final word as to what that technology is. Another thought I have is that one of the most important pieces of information to be generated is how things have progressed with time. Start-up of any new operation is always fraught with difficulties; consequently, costs and efficiencies--whatever--are not so good as you wish. But the crucial thing we should be looking at is the plant's actual continuous performance compared to projections and how quickly do the plants reach that level of performance. A protocol should provide for taking data over a period of time and such data are much more meaningful than a single point-piece of data. They tell us how it went and how we project we will end.

Mr. Tribelhorn:

That is essentially what was suggested be done on a monthly basis, though we certainly wouldn't pick it up monthly.

Dr. Jansen:

I think several of these questions have really dealt with what is called "respondent burden," that is, the evaluation time as a percentage of operation time. In other words, you don't want to spend more time evaluating what you're doing than doing. The right approach to that is somewhat similar to what Alden Ackels has talked about for quality control, namely, it needs to be re-evaluated. You want to know if you really need the information, because you don't want a lot of specifications that are going to be ignored. I think that is a good point, because the analysis itself needs to be cost-effective.

Dr. Lachmann:

Any other comments? If you think of others between now and departure, it would be very helpful to us in evaluating the protocol if you would give them in writing to Mr. Tribelhorn.

Work Group Reports and Additional Discussion - Thursday Afternoon

WORK GROUP I: PROCESS
Justin R. Jackson
Leader

(Editor's Note: All participants received assignments to work groups and topical outlines well in advance of the workshop, and each person was asked to review the topics in preparation for discussions. The discussion topic was "Identification of Future LEC Activitites," and within that context groups discussed aspects of process, product, marketing and technical support services. Please refer to Appendix III for work group goal, outlines and members.)

SUMMARY

This group felt that CSU should provide more information on LEC plant designs, including some items which do not directly relate to equipment. Such items as site selection, flexibility for system design, and building requirements were determined as necessary inputs by CSU for a complete design.

A set of criteria for selecting a site to build a factory should be provided to prospective groups. The criteria should be based on several items, including economics for transport and repairs, labor accessibility, area space requirements and power availability. By providing these criteria to potential users, there would be less chance of an improper site selection.

Design of the physical plant facility needs refinement. Guidelines should be established to help a potential site to design and/or contract for construction of the plant. Guidelines on plant building design, infestation control, future expansion, ventilation, sanitation, and product movement should be adopted.

The variability from one installation to another has been typically small, thus not allowing for a wide selection of designs. A selection of several designs for a specific product would introduce more variability. A comparative study on horizontal versus vertical systems would assist the decision-making process when considering the installation of a plant.

A suggestion was made to incorporate into the program an industrial engineer who would complement the existing staff and would assist in providing workable designs for LEC plants. The staff addition would make for a more systematic approach, since the industrial engineer is trained to identify often-overlooked details in present design developments.

SPECIFIC RECOMMENDATIONS

Several points on the processing equipment were discussed as given below:

Cleaning - More thought should be given to expanded equipment capacity, so that large quantitites of materials could be received over a short time period if necessary.

Aspiration - To improve both safety and environmental conditions in the plant, some work should be done in the area of dust removal.

Storage - Comparisons of bulk storage versus conventional storage should be made. Economic factors and possible design alternatives would help make decisions on what to use.

Plant Controls - More monitoring systems should be utilized which would allow management to oversee operations. Specifications for raw and finished products, along with necessary monitoring equipment, would provide data for cost and internal material movement control.

Conveying - The primary concern for conveying systems is sanitation. Conveyors should be upgraded from those presently used. The replacement conveyors should have capabilities for fumigation and normal cleaning. Pneumatic conveyors should be considered more often for LEC systems.

Proportioner Grinder - The compatibility of the existing equipment with other extruders should be investigated. Alternatives need to be identified.

Water Application - Tempering of raw products prior to extrusion was felt a viable alternative to the present water application method. Information on providing a water injection system directly into the extrusion chamber is a second alternative that should be considered.

Extruders - The capability for continuous operation of the Brady is still in question.

Wear problems were reported during the workshop which must be overcome to make the Brady a continuous duty extruder. Therefore, metallurgical evaluations should be made to improve the life of parts perticularly susceptible to wear. In addition, investigations should be made into broadening the uses of LEC for products other than weaning foods, including second generation products such as soups, snacks, and pastas.

A selection of LEC's should be made available. It is recommended that CSU look at other extruders which would meet existing LEC criteria or portions of the criteria.

Cooling - Coolers should be examined in more detail to reduce capital costs and improve efficiency.

Reduction Milling - A need for heavy duty mills is required to reduce maintenance costs and downtimes. More information on mills that can grind FFSF should be obtained through an intensive investigation. Alternate milling systems such as stone, attrition, and roller mills should be considered for reducing the final product.

Enrobing - Information should be made available for enrobing and coating equipment, identifying manufacturers, equipment models, and prices.

Packaging - Packaging machinery would help automate the system, as well as reduce contamination problems. Based on reports and discussions during the workshop, more information is needed on packaging machinery and packaging materials.

Maintenance - More tools are needed to perform the necessary repairs and maintenance of the equipment. Emphasis should be placed on developing a more thorough list of tools to be provided with the plant.

Miscellaneous - Investigations need to be made into the types of steel or material that should be used to make plant equipment. Concerns of black iron contamination plus other possible metallic contaminations should be considered before a recommendation is made.

Types of fumigation equipment should be looked at and the information provided to interested groups requesting it.

Distribution of the Plant Manual should be made in advance of the plant start-up to allow time for the group to become familiar with equipment operation.

CSU involvement in equipment installation, plant design, start-up, troubleshooting and follow-through was discussed. The level of assistance needed varies by site. Greater local involvement is desirable, and where that can be obtained, CSU involvement can and should be less. Areas where emphasis needs to be concentrated should be identified.

Mr. Tribelhorn:

There was some feeling among the group that possibly CSU has been having a little too much involvement with the training and technical assistance and the question was, just what level of input is required prior to CSU's leaving? We could not resolve it, and we hoped that we could get some comments from the rest of the group here as to how much assistance is required before the people in the plant can take over and solve their problems by themselves. Do we let the groups solve all their own problems, or do we make recommendations to help them, or what?

Mr. Sterner:

The other controversy we had concerned looking into the metallurgy of the Brady crop cooker and what to do about it. I would like to have both viewpoints stated at this time. You may want to address this, Ron; you take one side and I'll take the other.

The Brady crop cooker at this time is being sold very inexpensively because they want to reduce the inventory. What benefit is there to looking into the metallurgy--having CSU look into the metallurgy of the machine--to try to improve its wear life when the machine is so inexpensive to buy at this point? And if they do look into it, what results can be obtained?

Mr. Tribelhorn:

The position I was taking in terms of metallurgical work was that we need to do some more work in that area to possibly improve the longevity of those machines in the field. We have machines in production in various countries, and we would like to assist them at least to the point where they can decide either to go to a different machine or possibly to continue with the Brady.

Mr. Crowley:

It sounds like you are implying that the only Bradys there are, are the ones now in the field, and I think that might cause some misunderstanding. There is a supply of Bradys, and to my knowledge that supply will continue as long as there is a demand for them.

The Koehring Company has indicated that they no longer wish to stay in the business of making the Brady cooker, and they intend to sell the Brady cooker part of their business to another company. But in the meantime they are in that business; they have a supply of 100 machines available; they have indicated that they will continue to make machines if there is a demand for them; and they have indicated that there will be a continuing supply of spare parts. I think if there are weaknesses in the machine, for example, parts that wear out rapidly, they should be looked into.

Mr. Sterner:

Are you saying then that Koehring would adapt the Brady to your speficiations?

Mr. Crowley:

I can't speak for Koehring. However, CSU and others have come up with modifications. There are plans for different kinds of feeder systems and so on, and as frequently is the case with standard pieces of industrial equipment, when somebody uses them, they make their own modifications. If you want to put a hardened screw in, for example, this certainly can be done.

Prof. Amara:

There was a definite rumor that the Brady would no longer be produced, but now it is clear that the Brady is going on and we will still be able to get spare parts. Thank you for clarifying this point.

Mr. Mosha:

It is possible to incorporate into the system a mechanism to control infestation that may occur after the product has been cooked? I'm thinking of something like in the case of flour milling where you either impel the flour against some surface or you treat it lightly using mild heat. Too much heat, of course, will destroy your product, especially the American vitamins.

Mr. Jackson:

In the Sri Lanka plant and also to be incorporated into the Costa Rica plant is an entoleter--an impact insect destroyer like you described-- which impels the egg or larvae against the wall of the machine and destroys it. Installing it at the end of your line, just immediately prior to packing, should eliminate the need for any infestation control between the extruder and your packing. They cost about $6,800 and have a 2-month lead time.

WORK GROUP II: PRODUCT

Leslie Chin
Leader

INTRODUCTION

Improvements in the product under the following headings were considered: nutritional requirements and nutritional evaluation, product profile, country-specific recipes and quality assurance. For the purposes of this presentation, low cost is related to purchasing power, raw materials, availability and competitiveness.

We also discussed the application of this low-cost technology using agricultural by-products for the production of animal feeds, which would increase the availability of human foods.

We placed emphasis on weaning foods, as recommended by the first LEC workshop. Weaning foods are used to supplement the diet to improve the nutritional well-being of the child after it reaches the age of four months.

NUTRITIONAL REQUIREMENTS AND NUTRITIONAL EVALUATION

One recommended activity is to assess the vitamin and mineral content of the weaning food in relation to the standards derived from the needs of the target group in the specific countries, e.g., for Sri Lanka, increasing vitamin B_1 and B_2 and reducing vitamin B_{12} levels of fortification in CSB.

Work needs to be done on the stability and utilization of certain vitamins and minerals in relation to processing, storage and recipe preparation.

It is both desirable and necessary that before marketing, weaning foods be evaluated by the medical profession using metabolic studies.

PRODUCT PROFILE

We have considered formulations with different raw materials by proposing a product profile, and work is required in the following areas:

(a) Protein-energy ratio of the final product. This needs to be resolved by further work since there is a variety of current recommendations.

(b) Energy density. Work needs to be done on a recommended energy density of the product when cooked and as fed. This relates to the limited capacity of the infant stomach and inability to secure enough energy from foods with low calorie density.

(c) Fat content. Attention needs to be paid in general to the fat content and specifically to the essential fatty acid content, guided by the code standards for cereal-based weaning foods.

(d) Fiber content. The consensus was that grains should be dehulled to make the fiber content minimal. Further work needs to be done to resolve some of the differences in recommendations for maximum fiber content of weaning foods.

(e) Ingredients. We have emphasized the use of local raw materials which would be available at low cost.

COUNTRY-SPECIFIC RECIPES

Country-specific recipes should be safe and hygienically-prepared and related to traditional eating patterns. In home preparation the addition of expensive ingredients should not be recommended.

QUALITY ASSURANCE

Assurance of the quality of the product at the point of use is necessary. Standards of quality and systems of assurance need to be adopted. In particular, finished product standards must be adhered to, and if they are not, the product must not be put on the market.

Packaging is second to raw material in cost, and it needs to be optimized in relation to distribution channels, product formulation and length of storage.

Dr. Harper:

I would like to know what your group felt was needed to advance the implementation of LEC technology in the way of prototype products or additional ingredients. Did they feel sufficient work had been done to demonstrate this technology with enough ingredients, or are other ingredients and work required? Has there been a sufficient number of products demonstrated, or is the work basically on full-fat soy and blended foods insufficient? If the latter, were any recommendations made?

Dr. Chin:

Unfortunately, we didn't discuss that. Part of our approach was to optimize the use of time, so we decided to spend it on weaning foods in terms of the impact that we would have. I myself think that the points you raise are important, and I personally think that not enough work has been done. One of the possible applications that had excited me was the use of extruded cereal, possibly a by-product with urea, for dairy feed, thereby releasing some of the protein supplements for other uses. Would any of the other members of the group care to comment?

Prof. Amara:

I would like to emphasize the need for experimental research on product development. In a developing country, there is not enough of a specific raw material for everyone, but in Thailand--and especially in different areas of the country--we have different raw materials available. We need quite a lot of time to experiment with the raw materials to develop products that will suit the eating patterns of the various regions. There is much to be done along this line.

Mr. Lukoo:

I think we were emphasizing corn and soy, but other raw materials should also be considered. For instance, in the case of Tanzania we would probably like to go into things like common beans or oilseeds--things like groundnuts--which we actually have in greater quantity today than soybeans. This is a diverse question which involves such considerations as resources, a given country's protein efficiency ratios of the various combinations, and so forth.

Mr. Nyakunga:

I had some reservations regarding the recommendations made by the group in relation to dehulling of the soybean. They want to reduce the ash content of the finished product, but what percentage of the hull do they want removed? Also, I didn't understand what idea the group had to reduce the flavor of soybeans in the finished food products.

Dr. Lachmann:

I was part of the committee, and we felt that we ought to follow the standards which are set by either PAG or USDA for safety purposes. We don't know for certain what happens when we don't dehull, and since we're talking about weaning foods, we are very careful not to recommend anything that will contradict accepted nutritional standards. As to minimizing the soy flavor, that's a formulation question we did not discuss.

Mr. Nave:

One of the main problems in flavor is the cleaning of the beans to begin with. When you cook a pot of soybeans at home, if you have one or two broken ones in there, they all taste bad. I don't see any difference between that and extrusion cooking. You really have to clean your beans, taking out all the broken ones, the halves, the cracked ones and the discolored ones--it will make a big difference in your flavor. On another subject, why do you put milk in these formulas?

Dr. Chin:

That is something we in Guyana considered. One of the reasons is that--for the weaning food--the mothers to whom we give the product are going to add milk. We might as well put it in for her at a lower cost than she can buy it, because she is going to use evaporated milk--one of the most expensive forms of milk. We have arrived at the conclusion that the sales price of our product is equivalent to the total amount of money she would spend, let's say for a week, to buy both a weaning food and the milk that goes with it as it is acutally fed.

Mr. Mosha:

I would like to address Dr. Jansen on this matter of whether or not to add milk, because it is one of the controversial issues. There is evidence that quite a number of people cannot very easily digest milk, and this raises a question from the nutritional point of view about its use.

Dr. Jansen:

As far as I know, there is no reason from a nutritional standpoint to add milk to a corn-soy blend. However, from the standpoint of flavor or acceptability, there may be some other reason in a particular country or area. From a nutritional standpoint, the protein quality of corn-soy blend is adequate in terms of quality and quantity. The point of lactose intolerance has been a long-standing issue, regarding the use of milk to treat malnourished children. I don't think that, for instance, corn-soy milk has had any deleterious effects.

Dr. Nichols:

A marketing man can't resist making a comment here: Dr. Chin's observations about the reasons why they put milk into the product is a perfect example of the value of doing a little bit of research--what people consume, how they consume it, how they prepare it and how they serve it--and then building the results into the product the best way you can.

Prof. Amara:

I would like to support Dr. Jansen in not adding milk to corn-soy blends. In our formula of rice and soy we do not add milk either, and it is adequate nutritionally. I would like to add regarding the discussion of removing the beany flavor, that there has been quite a lot of work at Cornell on this. The results indicate that by using heat--about 80°C--you can remove the beany taste. It is interesting to note, by the way, that the people of Singapore or Hong Kong, who like to drink soy milk, prefer to have the beany taste in it.

Dr. Lachmann:

That is one of the problems we had in discussing product development--each country is different.

Mr. Crowley:

One of the capabilities of the extrusion cookers is to make textured vegetable protein. Mr. Nave described the strong interest in India of the consumers and users of textured vegetable protein, and I think Prof. Amara has demonstrated there is an interest in Thailand. Some of the extruders we have worked with, particularly the Brady, haven't shown good capability in doing that, but others--the MFM extruder for example--have. I would be interested in knowing what the group's interests are in textured vegetable protein as made by low-cost extrusion cookers.

Dr. Chin:

We haven't considered that, so I am only giving my personal views. I think we have believed that weaning foods are going to have the greatest impact. But inevitably, if one wants to optimize the use of the Brady both worldwide and in-plant--where you are trying to maximize the use of your plant--one needs to consider, as we are doing, the variety of products that you can make with the extruder. TVP, although it might not fill a particular function in terms of being low-cost will fill a particular market that I think is there.

Dr. Lachmann:

We did not really consider it because we were concentrating on weaning foods.

Prof. Amara:

We in Thailand are interested in producing TVP using the extruder and are working with an oil refinery to arrange to use its defatted soy residue for use in a texturizing factory. We are hopeful that textured vegetable protein represents an important source of protein to improve the diet of pregnant and lactating women.

WORK GROUP III: MARKETING

John P. Nichols
Leader

INTRODUCTION

Marketing as an area of management decision-making depends to a large extent on many social, cultural and human behavior factors. It was observed early in our discussions that this made the process of reaching a consensus very difficult. Each participant was dealing with a very different set of experiences, and we did not have the benefit of a well-defined common body of information as did some of the other discussion groups.

We did, however, identify several basic concerns which cut across the specific interests of individual participants and which would benefit from future research and analysis. Through a study of these in several different settings, it is felt that an experience base could be developed which would be sufficiently broad to allow useful general conclusions to be drawn.

RECOMMENDATIONS

1. The impact of pricing decisions was identified as an area in which more extensive work needs to be done. Noted specifically was a concern about the effect of price on level of purchase by specific target populations. It was felt that not enough is known about the sensititivity of the most "nutritionally-vulnerable" people to the level of price at which the product is sold or to subsequent changes in price. The effect of price on total level of sales and ultimate commercial viabilitiy is also an important consideration which needs attention.

It was recognized that conditions will vary widely from country to country and that LEC foods may be entirely different in different programs. However, benefits would result from careful study of current programs. As an example, commercial weaning foods are planned for several LEC projects. The results of these projects should shed some light on the pricing questions noted above if studied carefully.

To provide the basis for drawing useful generalizations, an effort will be required to monitor sales and identify trends in market penetration during the early stages of test marketing. Some idea of the prices of related or competing products should also be obtained. The major point is that a specific effort should be planned at the same time test marketing is undertaken.

2. Packaging was identified as a second area of concern. One specific question is whether different packages should be used in situations where LEC weaning foods are being introduced in both free and commercial channels. Arguments favoring use of the same package are based on the idea that use of the product by free recipients would be encouraged by the image of a marketable-quality product. Conversely, it is argued that the value or image of the product to customers in the marketplace would be lowered. If the packages are differentiated for the two distribution channels, then the commercial product will not be thought of as a "welfare" food; however, those who receive it free may feel they are getting an inferior product and thus be less enthusiastic about using it properly.

A related question is whether or not a low-cost package can be developed which will be competitive in the market. Monitoring of current and planned projects will provide a basis for generalization, though the subtle effects of color, artwork and related factors may prevent direct comparisons across country lines.

3. Distribution systems were discussed. The extent and sophistication of distribution systems appropriate for LEC foods were questioned. Can LEC foods be distributed using a less expencive system? If the full involvement of all levels of the system is needed to make the product widely available, can the cost of this be covered and still keep the retail price within reach of the target population? These are questions which will only be resolved through experience in the field.

4. The workgroup encourages all participants to document the objectives and results of commercial ventures in the LEC Newsletter.

5. The workgroup suggested a study designed to review current commerical LEC projects. The purpose would be to focus on documenting the marketing programs and developing an analysis of the results of each venture. These individual case studies would then be available as a basis for developing useful generalizations.

Dr. Harper:

I understand the complexity of what one goes through to establish new products that meet market needs. It is a very expensive, time-consuming and imprecise process, despite its sophistication. Since we are talking about low-cost appropriate technology, can we also talk about innovative low-cost appropriate marketing studies to tell us some of these answers without necessarily doing it quite like it is done in the U.S.?

Dr. Nichols:

I'm sure there are some opportunities for innovations, and I think we've seen all levels of sophistication in marketing research being applied to some of these projects. I don't criticize the project or the marketing research effort because it was not as extensive or sophisticated as something one would see in the U.S. I don't think we are talking about great expenditures of money in all cases. The dollar value of the first survey in Sri Lanka was about $7,000, and it is a fairly extensive project.

Mr. Corea:

In marketing one of our chief objectives is to spend as little money as possible on advertising in relation to the results that you want. We don't spend money just for the sake of spending it; you spend only the money you need to spend to get the desired objectives. A proper marketing strategy is adopted after capital research and thought. Then one can always prune and reduce marketing support expenditures to the barest minimum. This means the proper identification of target groups and proper decisions about objectives, so that we go in the correct direction in the best manner using the least possible resources. For instance, in Sri Lanka it is very cheap to use consumer contacts. In the West it is unthinkable, because it is very expensive. We have used it very cheaply for many years with a reasonable amount of success, so one can always use low-cost marketing support as well as low-cost technology in this field.

Dr. Nichols:

There is also the aspect of the question that more directly relates to low-cost marketing research: how can we gather some of this information more cheaply?

Mr. Corea:

That is even simpler, really, because it is a question of deciding what results you want. For instance, the use of a big sample may cost a lot of money, but the information you get from it will not be so different from information you get from a smaller sample. What you really want is not absolute results; what you want is an indication, you're looking for trends, so that a small sample with low field and tabulating costs will give you enough information to make decisions on which to take action. Obtaining information on things like advertising and packaging can be and is done all over the world with small samples of 15-25 people, which is very inexpensive.

Dr. Nichols:

Perhaps the appropriate technology here would be reducing expenditures by cutting back the size of sample, the scope of field work and the expensive out-of-pocket things, substituting for them very good technique, procedure and care in selecting the sample. They would be more assured of precise procedure in the questioning process and development of specific research objectives and hypotheses. In marketing or in any other kind of scientific research, you never know the exact answer; there is always a confidence interval around it. The reason we go to larger and larger samples in marketing than you might in other research is that you have more variability to start with, so you have to have a larger sample to get your confidence interval down to something you can deal with. In many cases, though, we may be able to cut back on size of samples and still live with the results. You'd have a bigger confidence interval; but I think the value here is the thought process you go through. You think about the decisions you have to make and where you can get the information to help you make them. And if you can't afford to do anything more than just go to secondary data and talk to some people, at least you have considered what the alternatives are and you've obtained the best data that you could afford to get.

Dr. Jansen:

I have a short comment on the effect of relative price on the purchase of food by the target population. At the time they were trying to market Incaparina in Colombia, they came to the conclusion that it was important to price it at the level of the second cheapest staple; in other words, if corn was the cheapest, the one that would be next to that. I'm not sure if they were able to do that because of their costs, and they weren't successful. But it does make the point that some of the experiences those countries had may very well be appropriate now that low-cost technology might be capable of doing some of the things they couldn't do then.

Mr. Nave:

Marketing is so indistinct --it's hard to sink your teeth into--so if we sit around waiting for the results from all our surveys, we will go broke. It seems to me that we have to set some basis for operation even when we don't have surveys or knowledge, because most of us are producing things that we need to get on the market. We already talked a bit about some of the things that may be worth keeping in mind, some techniques and approaches of marketing which are not necessarily based upon surveys but upon necessity. How do you actually go out and start selling your product whether you have a survey or not? Many of us are in that position.

Dr. Nichols:

I think what you're suggesting is that we need a kind of handbook on marketing low-cost extruded foods.

Mr. Nave:

Yes, or you relay a few techniques some people have used that seem to be effective so we can start working. We don't have big advertising budgets, so we've got to get on some sort of a person-to-person basis for the popularization of our products. We've got to have a certain attitude towards the people we are asking to distribute and sell our products, and we have to influence their thinking so that they are motivated and able to go out and sell our products for us--something that is not normally their practice. A lot of things like this are things that we can do whether we have a survey or not.

Dr. Nichols:

But going back to Mr. Corea's earlier point, there are some useful secondary data for those who are still contemplating getting into it. It takes time to generate the information you need, and you ought to be doing it while you're still thinking about buying that Brady and building that plant.

Mr. Nave:

I'm not against surveys and getting information, but you have to have something to fill the interim in certain cases.

Dr. Nichols:

Of course, if you are already in the business, you're probably the best source of information there is. It is your own experience, and you're generating a lot of information that you store up in your head to draw on to make these decisions. There is no reason why you can't think of that as being a secondary data source.

Prof. Amara:

Just as a point of information, we have quite a few camps in our neighboring country with many children receiving milk from the U.N. However, instead of using the product in the country, people are selling it in Thailand to buy rice for feeding their children. This is also affecting our market situation.

Mr. Mosha:

When we look at market promotion activities we need to consider who decides what to buy in a particular society. At the same time, who decides what the child will eat? In other words, where do we aim the promotional message?

Dr. Nichols:

As you indicated, it will have to be addressed to the person in the household who's making those decisions. We would normally consider that to be the mother and housewife.

: is true in your particular country and
, that is, she is the one who decides
or place that purchasing is done. the
prepared and the family is fed, then
ld direct your attention toward her.

res:

marketing this is one of the things we
ike to know, and everyone tries all
of ways to try to get this information
ho makes the buying decision. Surveys
parts of the world have shown different
, but I would say that it is a combina-
f family decisions. It is true that the
has the money, but the mother is gaining
portance in the decision-making process.
y still not have full equality, but in
ka we have found that where food is
ed, where soap and household detergents
t sort of thing are concerned, the
does have a large say in the matter.
the father has the say-so as to how much
chased, but I think where baby food is
ned the mother decides.

GROUP IV: TECHNICAL SUPPORT SERVICES

F. Merton Cregger
Leader

L CONCLUSIONS/RECOMMENDATIONS

ur analysis disclosed that there is
a great need for technical support
es. We consider that the program has
ped to the stage where it would be
ageous to establish a centralized source
hnical support of broad scope. Such a
lized source should provide easy access
tential users and develop sufficient
dge of other low-cost processing meth-
grains, pulses and oilseed mixtures to
that there is not too narrow a focus
and that the choice of processing
s will be appropriate.

IC RECOMMENDATIONS

ng

cond-generation type of training:

Short courses, perhaps to be made available as training modules, for managers/supervisors.

(1) Aspects of plant management and operations

(2) Program development

(3) Marketing

(4) Product development

(5) Evaluation

b. Development of training materials for attendees to utilize in multiplying the training received.

c. Development of bulletins and printed materials for dissemination to users and potential users--a sort of ongoing extension service.

Manuals

1. Thorough evaluation of new manuals.
2. Develop system for proper introduction of the manual.

Technology Transfer--In a sense, the whole discussion dealt with this issue but there are some basic comments that should be mentioned:

1. Technology transfer is much broader than the transfer of a mechanical technique or equipment utilization; it includes managerial and entrepreneurial skills, program development and evaluation techniques, systems and concepts.
2. Emphasis should be on local adaptability and the prospects for maintenance and replacements by and from local sources.
3. In order for transfer to take place, there needs to be improved methods of communicating an understanding of the technology. In addition to suggestions under other headings, we suggest the following:

   Establishment of a central place to provide technical support.

   More work on local machinery adaptations, location of in-country suppliers and local manufacturing of equipment and spare parts, with special emphasis on spare parts.

   Development of education/promotional materials which would provide summarized and easily assimilated explanations of the system, its potential and the factors that determine suitability.

Program Development

1. Feasibility studies.

2. Evaluation methodology not only of plant but also of social and commercial objectives and nutritional consequences.

Plant Design

1. More formalized and detailed plans and specifications.

2. Greater optimization of plant equipment with possible development of production modules.

3. More work on storage and handling.

Project Development/Education

1. More work on product shapes, taste improvement and different uses.

2. More work on packaging technology--both equipment and materials.

3. Study of gossypol and aflatoxin deactivation.

4. Development of additional mixtures and optimization of nutritional content.

Marketing Strategy

1. Differentiation of strategies in public and private sector programs.

2. Development of low-cost, promotional techniques.

Dr. Nichols:

I wonder if you could expand a little on the comment about differentiating between techniques for public vs. private sectors.

Mr. Cregger:

We didn't have time to discuss it in great depth, but there was a recognition that you can't use exactly the same marketing strategy in both sectors. I think a good clear definition of those differences--we don't really know what they are--would be helpful.

Dr. Nichols:

By "public sector" do you mean giving the product away free, or do you mean manufactured and sold by publicly-owned corporations?

Mr. Cregger:

Principally it's free distribution, but we were also thinking of its being done strictly by governmental agencies as opposed to a semi-governmental or private agency. If it's a direct function of a ministry, it can function in one way; if it is a semi-antonomous agency given the right by that ministry to do certain things, there may be other implications; and certainly if it is free vs. purchase, or free vs. subsidized purchase, again you have some differences.

Dr. Lachmann:

You talked about the methodology of program development. Could you elaborate on that?

Mr. Cregger:

We felt that there needed to be a lot more work on feasibility studies. A lot more R&D work on the project is necessary--getting your objectives and goals clearly in mind, getting your various strategies laid out, testing your assumptions against realities. A well-developed and applied feasibility study, with the proper disciplines represented is going to save a lot of heartache and cost later, so what we are mainly calling for is a systematic development of feasibility studies starting from the very concept through completion of the plant and distribution or marketing of product.

Mr. Corea:

I would like to ask Dr. Harper whether it is possible to reduce the importation of wheat by inserting extrusion plants in the two flour milling facilites in Sri Lanka, and extruding other cereals with a small percentage of soy to put into the wheat flour?

Dr. Harper:

I don't think extrusion technology is related to wheat substitution except where you might want to apply a protein fortificant--for instance, extruding something like full-fat soy flour and adding it to extend the bread and also to nutritionally fortify it. There are techniques, however, to use a variety of other flour materials. There has been work done on cassava and on adding corn and other things to make what they call a "composite bread formulation," which would be in a sense extending wheat flour with local flour or ingredients, thus reducing dependence on imported wheat.

Dr. Chin:

The approach we are taking to this, after determining that wheat is our largest food import, is to look at the potential of the Brady to produce something like a puffed breakfast cereal, a product that has a high profile and positive image. Our objective is to reduce by 5% the amount of wheat consumed as bread with this breakfast cereal and to get the same saving in foreign exchange.

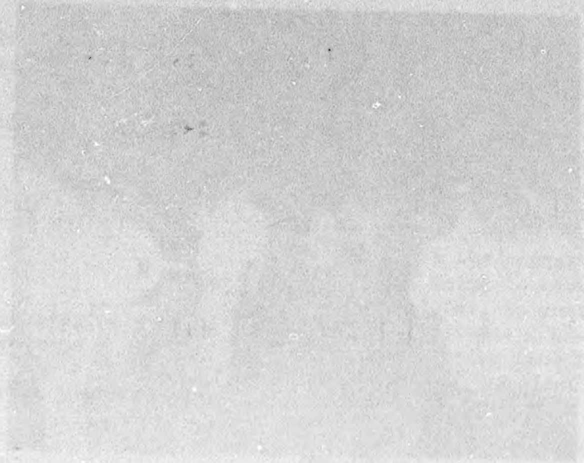
Mr. Bleyer:

Mr. Fox told us yesterday that 60% of this is art and 40% is science. The numbers do not mean much, but they do make one imagine what is involved in these activities: products, taste, nutrition--we are speaking about things that can't be expressed in exact mathematical terms. When we speak about marketing, we are speaking about an economic and social area that involves mathematics but is not a mathematical science. When we speak about machinery and all the things that are involved in this area, we are saying that CSU has helped to make this area one of a little more science and less art. Their reports have helped us in one way or another to solve our problems in the engineering field. We hope that this help and work to make the process more scientific will be continued.

Dr. Lachmann:

Thank you Mr. Bleyer. Before we have the final remarks, we here at the workshop would like to express our gratitude to its organizers, particularly Ron Tribelhorn and David Wilson. I would also like to thank all the people from Tanzania who have participated in this particular congress.

Participants had the opportunity to discuss their activities less formally during a group barbecue buffet dinner at the Africana Hotel in Kunduchi Beach.



Closing Remarks

Mr. C. Y. Mpupua, General Manager 1/
The National Milling Corporation
Dar es Salaam, Tanzania

I feel honored to have been invited to speak to you at the close of this Second International Low-Cost Extrusion Cooker Workshop.

We in Tanzania, and in particular the National Milling Corporation, regard it a great honor that we were requested by the U.S. Agency for International Development and Colorado State University to host this important workshop which has drawn participants from different national institutions around the world.

As you may know, the Agency for International Development (AID), through a contract with the U.S. Department of Agriculture, has actively supported efforts to identify methods of producing nutritious foods at low costs in developing countries. One such method by which this can be achieved is that of extrusion cooking of indigenous cereals and legumes. A simple, inexpensive machine within reach of the financial capabilities of developing countries that would process and produce a finished product retaining all the nutritive values of the ingredient foods must be the ultimate objective of all design efforts. The Brady crop cooker, which is a simple, inexpensive machine designed and tested by USDA and ourselves in this country, could be one of the many such cookers which could be developed as an excellent means of making nutritious foods and food ingredients. We believe, therefore, that your four days of intensive deliberations and exchanges of experience and views have paved the way for further developments of the existing extrusion cooker designs.

Judging from reports we were receiving, the workshop objectives were most certainly achieved. The lively discussions conducted in this room and outside have confirmed our optimism on the success of this workshop. We wish to thank you, Mr. Chairman, and the other presiding chairmen of the various sessions for the able way you have conducted them.

The scope of low-cost extrusion cooker activities, as has been expressed by other speakers, is world-wide. We believe that experiences shared among us during the workshop will be of immense value to us here in Tanzania and other nations. The holding of this workshop in the course of the internationally-declared "Children's Year" is more than timely. Since the beneficiaries of this technology will mostly be infants, let the "Children's Year" see a further development of this technology so as to produce even more simple and inexpensive machines capable of being used as small-scale industries by people in rural areas.

Mr. Chairman, ladies and gentlemen, the workshop will soon be closing. I wish to take this opportunity on my own behalf and on behalf of my colleagues in the Ministry of Agriculture and the National Milling Corporation to express my sincere appreciation for the kind encouragement given to us as hosts of this workshop by the Honorable James Spain, the U.S. Ambassador to Tanzania. It was through his good counsel that it was possible for Tanzania to host this international workshop.

We also wish to extend our thanks to Dr. Steversen, the Director of USAID in Tanzania, whose efforts to secure funds enabled us to fulfill our dreams. Furthermore, thanks to Mr. R. Tribelhorn of CSU for the able manner in which he planned and organized this workshop. It was through his tireless efforts here in Dar es Salaam and back home in the U.S. that we were able to conclude the preparatory task on time. Last but not least, Mr. David Wilson, the Program Coordinator, and Mr. Harshbarger, of the USAID Office in Dar es Salaam, who worked closely with NMC staff to make this workshop a success.

A workshop cannot be a workshop without participants. It is the active support of you distinguished participants and your contributions during the four days of discussions that enabled us to make this workshop a success. I wish to thank you all for your respective contributions.

You are soon going to leave for your respective homes. We can only assure you of our having enjoyed your company, respected your views and shared profitably your experiences. But before you leave, you may perhaps be willing to change your departure plans so as to be able to visit our National Parks to view the game. You are all welcome to do so. Finally, Mr. Chairman, I wish to thank you again for the able way you presided over the workshop, and I wish you and all the participants a safe and happy journey home.

1/ Mr. Mpupua's remarks were made on his behalf by Mr. Tibenderana, NMC Establishment Officer.

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[illegible]

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[illegible]

Closing Remarks

Mr. Ron Tribelhorn
Colorado State University
Ft. Collins, Colorado, U.S.A.

I have enjoyed hearing the comments of everybody who has participated in this workshop. Through the experiences that have been presented here and the information gathered, we have all grown in our knowledge of LEC systems, applications and projects. There are certain individuals whom I would like to single out to thank for their continuous help throughout the conference: Edwin and Wayne Dysinger, who have done a lot of the leg work for us, among other things helping us to get our papers printed; Mrs. Gail Pate, who recorded all of our comments; the U.S. Embassy personnel who have assisted us in several matters throughout the conference; all USAID personnel who have helped, and especially Mr. William Miller and staff, who provided us with fiscal support services throughout the conference, and Mr. Jake Harshbarger, without whose assistance the workshop would not have taken place. Next, I would like to thank NMC for agreeing to act as co-host for the workshop and the baby food plant personnel for putting on an excellent demonstration Monday afternoon. Special thanks go to Mr. Benedict Nyakunga for coordinating workshop activities on behalf of NMC and to Mr. Kepakepa for doing an excellent job in setting up the tour Monday afternoon. I would like to thank all the presiders and moderators during the various sessions of the workshop. They have done a fine job, as have all those who have presented the papers which contributed to the betterment of the project. I would also like to thank the workgroup leaders for performing their difficult task so well; as a result of their good work, we've gained some more understanding as to what needs to be done in future LEC activities. Finally, I would like to thank AID/Washington for providing the support for the workshop, as well as the Tanzanians for their gracious hospitality. Now I would like to ask someone who has worked on the LEC project a long time--and that is Dr. Harper--for some additional closing remarks.

Dr. Harper:

It is important to put these types of meetings into perspective. Why are we really here, and why is this so important? I think all of us have a genuine interest in working toward a solution to world food problems and toward world self-sufficiency and development. These are complex, integrated problems; sometimes because of the complex nature of these problems and sometimes because of all the inner workings and technological ramifications that are necessary to make things happen, we lose sight of this important factor. Simply stated, we are interested in producing low-cost foods locally to meet nutritional needs. During this conference we have discussed what we mean by low-cost, what we mean by appropriate, etc. Let me read parts of this letter--I think it puts everything into perspective--which is signed "Concerned Mother" and which appeared in the "Daily News" of Dar es Salaam today. It's from a mother who echos the concern of mothers all over the world to feed their children nutritious foods at a price they can afford. And it asks how can we do this? It says meat costs 20 shillings/kilo; fish, 20 shillings/kilo; green peas, 15 shillings/kilo; eggs, 30 shillings/tray; beans, 6 shillings/kilo; tomatoes, 8 shillings/kilo; onions, 7 shillings/kilo; and baby foods, 15 shillings/kilo. These are some typical prices given, and our experience in Tanzania using LEC technology is that it produces foods at less than 4 1/2 shillings per kilo, so we really are talking about a low-cost, nutritious and appropriate food. I think this is really what we are all about, and I want to congratulate everyone who helped make this enlightening workshop possible. Thank you.

Mr. Crowley:

On behalf of the sponsors, AID and USDA, I want to thank you all very much for being a part of this workshop. During the course of this week, I've talked with quite a number of you about your attitudes toward the workshop--whether it was useful or not--and there was a consensus that this workshop, like the earlier one 2 years ago, was a valuable addition to your experience and that you derived a great deal from it. I think this has come about because of the hard work done by a number of people, the people at CSU and, perhaps more important, the work of you who have been participating in the program over the years.

I think you can take a great deal of pride in the results of your work. I hope that in another two years or so there will be another workshop where we can get together to see what we've learned as a result of the activities planned at this one.

Mr. Camacho:

I would like to make a reflection on behalf of all of us. All of us know the problem of malnutrition, and now that we have one of the solutions to this problem, we cannot go back. For myself and for my country, we will go forward, fighting with this technology to help solve the problem of malnutrition. Thanks to everybody here, and particularly the Tanzanian people.

Mr. Nyakunga:

We Tanzanians are very happy that this useful seminar has been held in our country. We wish you well and hope you have enjoyed your stay in Tanzania.

Mr. Tribelhorn:

With that in mind, I think we can now close the Second International Low-cost Extrusion Cooker Workshop, and I thank everyone for his or her participation and continuing support.

Appendix I

PARTICIPANTS

SECOND INTERNATIONAL LOW-COST EXTRUSION COOKER WORKSHOP

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[1/] Although Dr. Cheigh was unable to attend the workshop, his formal paper is included in these proceedings.

[2/] Although Dr. Salazar de Buckle was unable to attend the workshop, her formal paper is included in these proceedings.

[3/] Mr. Kepakepa is employed by the Tanzania Food and Nutrition Center and is on assignment to the National Milling Corporation.

[4/] Mr. Wilson is employed by Colorado State University and is on assignment to USDA.

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Appendix II

PROGRAM

SECOND INTERNATIONAL LOW-COST EXTRUSION COOKER WORKSHOP

Sunday, January 14

7:00 - 8:30 p.m.	Registration/Mixer Executive Room, Kilimanjaro Hotel	

Monday, January 15

Morning Session -- Dr. G. Richard Jansen, Presiding
Department of Food Science and Nutrition
Colorado State University

8:45 - 9:00	Late Registration	
9:00 - 9:10	Welcome	- Dr. G. Richard Jansen Department of Food Science & Nutrition Colorado State University
9:10 - 9:20	Welcome	- Mr. Johnson Kihampa Executive Chairman The National Milling Corporation
9:20 - 9:25	Opening Remarks	- The Honorable James Spain U.S. Ambassador
9:25 - 9:30	Opening Remarks	- Dr. Howard Steverson, Director USAID/Tanzania
9:30 - 9:50	Inaugural Address	- Mr. S. A. Madallali Principal Secretary Ministry of Agriculture United Republic of Tanzania
9:50 - 10:15	Coffee	
10:15 - 10:35	"An Overview of the AID Nutrition Program"	- Dr. Albert Henn Health, Nutrition & Population Officer USAID/Tanzania
10:35 - 10:55	"Transferring LEC Technology to Developing Countries: From Concept to Application and Beyond"	- Mr. Paul R. Crowley Nutrition & Agribusiness Group Office of International Cooperation & Dev. U.S. Department of Agriculture

10:55 - 11:15 Topical Speech:
"LEC Technology
Where Does It Fit?"
- Dr. Judson M. Harper
Department of Agricultural & Chemical Engineering
Colorado State University

Country Reports

11:15 - 11:35 Bolivia
- Mr. Pedro Bleyer
NUTRINAL
Santa Cruz, Bolivia

11:35 - 12:00 Discussion

12:00 - 1:30 Lunch

Afternoon Session

- Mr. Benedict Nyakunga, Presiding
The National Milling Corporation
Dar es Salaam, Tanzania

1:30 - 1:35 Introductory Remarks

Country Reports Cont'd

1:35 - 2:20 Costa Rica
- Dr. Guillermo Chaverri
Social Development & Family Program
San José, Costa Rica

- Mr. Delbert Clark
PRONUTRE
San José, Costa Rica

- Mr. Justin Jackson
CARE
San José, Costa Rica

2:20 - 2:50 Tanzania
- Mr. Mamie Lukoo
Tanzania Food & Nutrition Center
Dar es Salaam, Tanzania

- Mr. Venant Kepakepa[1]
The National Milling Corporation
Dar es Salaam, Tanzania

2:50 - 5:30 Tour of the National Milling Corporation
"LISHA" Baby Food Plant

Tuesday, January 16

Morning Session

- Dr. Alvin Siegel, Presiding
INTSOY International Soybean Program
University of Illinois at Urbana-Champaign

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[1] Mr. Kepakepa is employed by the Tanzania Food and Nutrition Center and is on assignment to the National Milling Corporation.

00 - 8:35	Introductory Remarks	
35 - 8:55	Discussion of Plant Tour	
55 - 9:15	"The Food for Peace Program"	- Mr. H. Peters Strong Regional Food for Peace Officer USAID/Kenya
15 - 9:30	Discussion	
Country Reports Cont'd		
30 - 10:00	Guyana	- Dr. Leslie Chin Mr. Vickram Oditt The Guyana Pharmaceutical Corporation Georgetown, Guyana
:00 - 10:15	Coffee	
:15 - 10:35	Honduras	- Mr. Rigoberto Alverado Ministry of Natural Resources Tegucigalpa, Honduras
:35 - 10:55	India	- Mr. Robert Nave Soy Production & Research Assoc. Bareilly, India
:55 - 11:15	Indonesia	- Mr. Atjeng Muchlis Institut Pertanian Bogor Bogor, West Java, Indonesia
:15 - 11:35	Korea	- Dr. Walter Bray Meals for Millions Foundation Santa Monica, California
:35 - 12:00	Discussion	
:00 - 1:30	Lunch	
Afternoon Session		- Mr. Hamis Lukoo, Presiding Tanzania Food & Nutrition Center Dar es Salaam, Tanzania
30 - 1:35	Introductory Remarks	
35 - 2:05	Topical Speech: "Nutritional Aspects of the LEC Program at Colorado State University"	- Dr. G. Richard Jansen Department of Food Science & Nutrition Colorado State University
05 - 2:25	Discussion	
Country Reports Cont'd		
25 - 2:45	Mexico	- Mr. Armando Camacho Griensen Center for Technological Research and Assistance Chihuahua, Mexico

2:45 - 3:05	Philippines	- Dr. Ignacio Pablo Philippine Inst. of Nutrition Food Science & Technology Philippine Women's University Manila, Philippines
3:05 - 3:20	Coffee	
3:20 - 5:30	Panel Discussion	- "Characteristics of LEC's and Manufacturing Experiences"
	Moderator	- Mr. Alden Ackels
	Panelists	- Mr. Wayne Fox - Mr. Hank Sterner - Mr. Ron Tribelhorn

Wednesday, January 17

Morning Session

- Dr. Ignacio Pablo, Presiding
Philippine Inst. of Nutrition,
Food Science & Technology
(PINFST)
Philippine Women's University
Manila, Philippines

8:30 - 8:35	Introductory Remarks	
8:35 - 8:55	Topical Speech: "Commercial Marketing of LEC Foods"	- Dr. John Nichols Department of Agricultural Economics Texas A & M University
8:55 - 9:15	Topical Speech: "Commercial Thriposha Consumer Acceptance Test - Analysis of Principal Findings"	- Mr. Nihal Corea Lever Brothers Colombo, Sri Lanka
9:15 - 9:45	Discussion	
9:45 - 10:00	Coffee	

Country Reports Cont'd

10:00 - 10:30	Sri Lanka	- Dr. Beatrice De Mel Ministry of Health Colombo, Sri Lanka - Mr. Earl Goodyear CARE Thriposha Project Colombo, Sri Lanka

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10:30 - 10:50 Thailand - Professor Amara Bhumiratana
Inst. of Food Research & Product Development (IFRPD)
Kasetsart University
Bangkok, Thailand

10:50 - 11:20 U.S.A. - Mr. Ron Tribelhorn
Dept. of Agricultural & Chemical Engineering
Colorado State University

11:20 - 12:00 Discussion

Afternoon Free for Private Discussion

Thursday, January 18

Morning Session - Dr. Fernando Sanchez Arellano, Presiding
Dept. of Scientific Affairs
Organization of American States

8:30 - 8:35 Introductory Remarks

8:35 - 8:55 Topical Speech: "Management Considerations in LEC Enterprises" - Mr. Alden Ackels
Santa Rosa, California

8:55 - 9:15 Discussion

9:15 - 9:30 Coffee

9:30 - 9:35 Introduction to Work Groups

9:35 - 11:30 Work Group Discussion - Topic: "Identification of Future LEC Activitites"

1. Group I - Process - Mr. Justin Jackson, Leader
CARE/Costa Rica
2. Group II - Product - Dr. Lesie Chin, Leader
Guyana Pharmaceutical Corp.
3. Group III - Marketing - Dr. John Nichols, Leader
Texas A & M University
4. Group IV - Technical Support Services - Mr. F. M. Cregger, Leader
CARE/New York

11:30 - 12:00 Report Preparation

12:00 - 1:30 Lunch

Afternoon Session - Dr. Alfred Lachmann, Presiding
Nutrition & Agribusiness Group
Office of International Cooperation & Development
U.S. Department of Agriculture
Washington, D. C.

1:30 - 1:35 Introductory Remarks

1:35 - 1:55	Topical Speech: "Evaluation Protocol of LEC Demonstration Projects"	- Mr. Ron Tribelhorn Dept. of Agricultural & Chemical Engineering Colorado State University
1:55 - 2:15	Discussion	
2:15 - 3:45	Work Group Leaders' Reports & Discussion	
3:45 - 3:55	Closing Remarks	- Mr. C. Y Mpupua[2] General Manager National Milling Corporation
3:55 - 4:00	Closing Remarks	- Mr. Ron Tribelhorn Dept. of Agricultural & Chemical Engineering Colorado State University

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[2] Mr. Mpupua's remarks were presented on his behalf by Mr. Tibenderana of NMC.

Appendix III

WORK GROUP GOAL, OUTLINES AND MEMBERS

WORK GROUP DISCUSSION TOPIC:
"IDENTIFICATION OF FUTURE LEC PROGRAM ACTIVITIES"

Goal of Work Groups

Within the four categories to be discussed (i.e., Process, Product, Marketing and Technical Support Services), which specific elements require improvement or additional work? What kind of improvement or work is required and why? How might it be done most economically within the context of low-cost technology?

(If, in a group's judgment, elements have been omitted, add them to those listed and apply above questions.)

Group I: Process

A. Pre-processing--cleaning, dehulling, washing, screening, etc.

B. Processing--extrusion, cooling, grinding, conveying, blending, etc.

C. Post-processing--fortification, enrobing and coating, packaging, etc.

D. Miscellaneous--maintenance, spare parts, quality control and assurance, sanitation, plant operation and design, finances, procurement, etc.

Group Members

Justin R. Jackson, Leader

Delbert Clark
Earl Goodyear
Hank Sterrer
Ron Tribelhorn
Walter Bray
Wayne Fox
Venant Kepakepa
Guenther Hoemer
Benedict Nyakunga
Vickram Oditt
V. S. Sharma
Ms. Rutabanzibwa

Group II: Product

A. Nutritional requirements and nutritional evaluation.

   1. Definition of county-specific needs.

   2. Evaluation, including digestibility and availability of nutrients.

B. Formulations with different raw materials for ingredients.

   1. Cereals--corn, wheat, rice, millet, sorghum, etc.

   2. Legumes--chickpeas, cowpeas, bean varieties, etc.

   3. Oil seeds--soy, peanut, cottonseed, sunflower.

   4. Fats and oils--vegetables oils.

   5. Vitamins and minerals.

   6. Other--e.g., coconut.

C. Development of country-specific recipes

D. Miscellaneous--sanitation, packaging, storage, acceptability, quality control of ingredients in final products.

Group Members

Leslie Chin, Leader

Amara Bhumiratana
Alvin Siegel
Beatrice De Mel
Ignacio Pablo
Alfred Lachmann
Aleck Mosha
Hamis Lukoo
Mwamimi Jana
H. Peters Strong
P. W. Dysinger
Abeba Gobezie

Group III: Marketing

A. Distribution of LEC foods to commercial channels.

1. Considerations in defining marketing strategies:
    - a. Pricing considerations (degree of subsidization, if any)
    - b. Packaging
    - c. Promotional activities
    - d. Factors influencing selection of distribution channels
    - e. Product characteristics (functional and sensory)
2. Evaluation and research considerations:
    - a. Study of consumption patterns
    - b. Consumer acceptance
    - c. Marketing testing
    - d. Image of domestic product vs. imported product

B. Selected factors of above relating to existing or planned redistribution systems.

Group Members

John Nichols, Leader

Robert Nave
Guillermo Chaverri
Nihal Corea
Armando Camacho Griensen
Pedro Bleyer
Paul Crowley
Charles Alexander
Albert Henn
F. Shoo
L. M. Kimati
P. Kingamkono
J. Baseka

Group IV: Technical Support Services

A. Training

B. Manuals

C. Technology transfer

D. Financial planning

E. Program development

F. Plant design

G. Product testing

H. Marketing strategy

I. Problem-solving for all elements in Groups I through III

Group Members

F. Merton Cregger, Leader

Judson M. Harper
Rigoberto Alvarado
Fernando Sanchez
Atjeng Muchlis
G. Richard Jansen
Alden Ackels
Jake Harshbarger
Edward Kalundwa
A. M. Hiluka

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